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BULLETIN NO. 23—NEW SERIES.

U. S. DEPARTMENT OF AGRICULTURE,

DIVISION OF ENTOMOLOGY.

SOME INSECTS

INJURIOUS TO GARDEN CROPS.

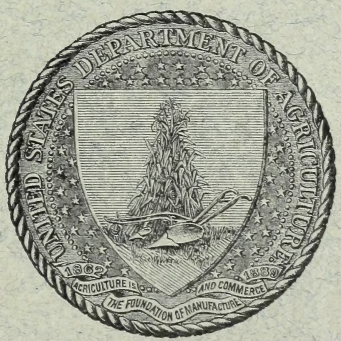
A SERIES OF ARTICLES DEALING WITH INSECTS OF THIS CLASS.

PREPARED UNDER THE DIRECTION OF THE ENTOMOLOGIST,

BY

F. H. CHITTENDEN,

ASSISTANT ENTOMOLOGIST.



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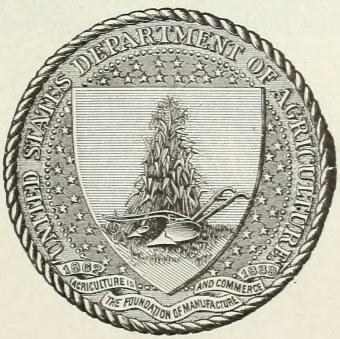

WASHINGTON:
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1900.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Entomology,
Washington, D. C., February 17, 1900.

Sir: I have the honor to transmit herewith a manuscript containing a series of articles dealing with the subject of insects injurious to garden crops, prepared by Mr. F. H. Chittenden, of this Division. Similar articles, by the same writer, have been published from time to time in Bulletins Nos. 10 and 19, new series, of this Division, also in various circulars, and in the Yearbooks of the Department for 1896 and 1898. The general subject has been under investigation for several years with the plan of publishing, ultimately, a complete volume on the garden insects of the United States for the practical use of truck farmers and gardeners. The articles which have been published and these which are presented have been prepared (where not preliminary or supplementary to more complete accounts) in detail, giving the complete history, as far as is known, of each species treated, a work which involves a great amount of original study, and which is published in full as a matter of record and for the use of working economic entomologists as well as of farmers. It is planned, however, in the completed report to condense all of this matter into an easily understood and practical working form. I recommend the publication of this group of articles as Bulletin No. 23, new series, of this Division.

Respectfully,

L. O. Howard,
Entomologist.

Hon. James Wilson,
Secretary of Agriculture.

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PREFACE.

The series of articles here presented in bulletin form under the title "Some insects injurious to garden crops," is in continuation of work done by the writer in previous years on the same subject, the results of which have been announced in different publications of this Department, and are for the most part based upon observations which have been made during the year 1899, although many of the species treated were under more or less continuous observation prior to that time.

Some of the species of insects which are considered are more or less spasmodic or sporadic in the nature of their attack and injurious only in seasons which have been unusually favorable to their increase. A certain proportion of these are for this reason of secondary importance, economically speaking, since in ordinary years of comparative scarcity they find nutriment sufficient for their needs in various wild plants and weeds, being driven to attack cultivated or other useful plants only in their seasons of greatest abundance. Some few of these are as yet comparatively little known, having done no material damage, but several are increasing in noxiousness and those which have never assumed great importance are liable to become so at any time, at least periodically or locally. Certain of the species under consideration, however, are of the highest economic importance when they occur in excessive numbers, and two of these, the destructive green pea louse and the fall army worm, have been among the most troublesome pests of the past year.

As in the case of previous general articles on insects affecting garden and orchard crops, the writer has endeavored to treat each species in all its relations, descriptive, historical, biologic, and economic. An effort has also been made to furnish not alone lists of exact localities in which each species has been captured or observed at work, but to define as nearly as possible from these data its geographic range, whether an inhabitant of this or that life area, and whether the natural range has been extended by a corresponding increase in the cultivation of its food plants and by commerce.

A series of investigations on certain species of insects which attack cruciferous and cucurbit crops was planned for the season, but was necessarily postponed on account of the scarcity of the insects them-

selves, due in great part to atmospheric conditions during the winter of 1898–99, which materially interfered with their hibernation, as already explained in an article by the writer in Bulletin No. 22, pages 51–64. A few cruciferous pests, however, came under observation, and two species were given special study.

Observations on insects which affect beans and peas have been continued, a considerable number of the species here treated being known to attack edible leguminous plants.

One of the most interesting insects of the year from the naturalist's standpoint is a gall-forming vine-borer affecting Lima beans, a species as yet not seriously injurious but capable of considerable injury should conditions favor a further increase in its numbers. It was unknown to science at the time its study was begun. The same is true of a small Tingitid bug affecting beans in Alabama and the plant-louse previously mentioned, which has been seriously injurious to peas over a wide extent of the eastern United States, Nova Scotia, and Canada, and which has been considered in Bulletin No. 20, pp. 94–99, and elsewhere. These three species were described by Messrs. G. D. Hulst, Otto Heidemann, and W. G. Johnson, respectively, within a few weeks of the completion of the manuscript of this bulletin.

Among other bean- and pea-feeding insects which have come under observation are the smaller corn stalk-borer, which had not been known as troublesome since the first report of its injuries in 1881, and the Mexican bean weevil.

The pale-striped flea-beetle, a well known pest in the central portion of this country from New Jersey to Colorado and New Mexico, has been studied, and some new facts in its life history have been gained. This species is one that has not hitherto received special attention in previous publications of this Division, which is also true of several other insects mentioned in this bulletin.

Among cruciferous pests of the year the cabbage curculio and the imported cabbage webworm were conspicuous, and the former, though not so injurious as in certain previous years, occurred in numbers sufficient to afford a good opportunity for its study. Considerable has been added to our previous knowledge of the webworm, which has already caused serious injury in the Gulf region, and is evidently destined to become one of the most serious pests of the Southern States, and as troublesome in time to the truck grower as are the harlequin bug and cabbage worms at the present time.

Considerable attention has been given to the strawberry flea-beetle and the common rhubarb curculio, and rather full accounts of both species are furnished. Some new facts in the life history of the bean leaf-beetle and imbricated snout-beetle have been ascertained which add somewhat toward a complete knowledge of these insects.

Prominent among insect pests of the year 1899, and perhaps as

troublesome as any insect of the season, if we take the number of crops and the area of territory affected into consideration, was the fall army worm. Although properly a field crop insect, it does great damage in vegetable gardens in exceptional seasons like the past, and as at such times it affects a great number of garden crops, it may, for convenience, be appropriately considered, with regard to recent injury, in the present bulletin.

A departure has been made in presenting general accounts of a few species of insects which have not been under personal observation as regards their life history, habits and development. The principal of these are the strawberry crown moth and the black gooseberry borer, both pests of the Pacific States, and restricted to that region.

For bibliographical purposes it should be stated that, as in the writer's previous bulletins, Nos. 8 and 19, the comprehensive title used for the present publication is assumed as a matter of convenience, and that each article is in a manner complete of itself, having no especial bearing on either that which precedes or follows it, and hence each article should be properly indexed separately.

In conclusion the writer desires to thank those who have cooperated with him in completing the accounts here presented, and desires to acknowledge with gratitude the kindness of his official colleagues and correspondents of this Division for favors which will be duly mentioned in their appropriate places.

Of the illustrations here used 16 are original, and of these all except figure 8, which was drawn by Mr. Heidemann, were prepared from drawings made by Miss Sullivan from selected fresh material and under the writer's personal supervision.

F. H. C.

SOME INSECTS INJURIOUS TO GARDEN CROPS.

A NEW VINE-BORER OF LIMA BEANS.

(*Monoptilota nubilella* Hulst.)

BORERS IN THE STALK OF BEANS.

Until the appearance of a short note by Dr. A. D. Hopkins and Mr. W. E. Rumsey in Bulletin 44 of the West Virginia Agricultural Experiment Station, published in April, 1896 (p. 303), no boring insect, as far as the writer is aware, was known to infest the stalk or vines of the bean plant. The note in question mentions, under the heading "The bean-vine borer," that this was a new pest, and was observed in Wood County, W. Va., in July, 1893, where considerable damage was done, attention having been called to this form of injury by Mrs. Bradford Neal. The larva was described as a whitish worm, about an inch long and resembling very closely the well-known squash-vine borer (*Melittia satyriniformis*). The attack was upon pole Lima-bean vines, usually at a point two or three feet above ground. The moth was not reared, hence the species of insect was not identified.

In the fall of 1898 the writer noticed numerous large gall-like swellings upon Lima beans growing in Maryland near the District of Columbia line. The following season material was obtained for study and illustration, and the species was reared to the adult. During this same year Prof. F. S. Earle, of Auburn, Ala., sent specimens of the larvæ of borers in beans, one sending being made in June and another in August. From the first only a single male moth was obtained, and the second sending was an entirely different species of insect, the smaller corn stalk-borer (*Elasmopalpus lignosellus*). To the best of the writer's knowledge, neither of these two species of borer has been identified with injury to the bean plant until the present time.

Of the first sending received from Auburn, Ala., a larva issued *en route*, being near maturity at the date of its receipt, June 15. The moth developed July 7. Larvæ were not abundant at the time of writing.

A peculiarity in regard to the noticed appearance of this species in its more northern range is that it could not be found in any other locality visited, not even in gardens within from one to three miles of the place where attack was first noticed. In short, infestation

could be detected only in this one garden and only to pole Lima beans. Dwarf Limas, wax and navy beans in the immediate vicinity as elsewhere were not troubled.

NATURE OF ATTACK OBSERVED IN MARYLAND.

During November, 1898, vines of Lima beans growing in a garden in the vicinity of Cabin John Bridge, Maryland, were noticed with numerous large gall-like swellings upon them, the swellings being particularly evident where the vines were eroded and the injury accentuated by rubbing against a high lattice fence upon which they grew. Unfortunately it was too late that season to identify the insect which caused this damage, as all the plants were dead and dry and the insects had long since deserted their early homes. The injury bore some resemblance to that caused by the well-known stalk borer, *Gortyna nitela* Gn., which attacks a great variety of plants. The galls, as these swellings may be called, are quite large in some cases, and it was quite evident, as was subsequently verified, that when they occur in such numbers as in this instance they cause considerable drain upon the vitality of the plant which has a corresponding effect upon the production of seeds or beans.

A lookout was kept the following summer for an early attack of the same species, but unfortunately only a small planting of Lima beans was made in the infested garden, and no vines were planted along the fence. Judging by the number of galls seen in 1898, it seems probable that an immense number of the larvæ came to maturity that year, but there were comparatively few plants infested the following year.

Of the moths reared, the single male from Alabama and a female from Maryland were referred to Rev. George D. Hulst, of Brooklyn, N. Y., a specialist in the Phycitidæ, who determined them as of one species representing a new genus and a form as yet undescribed, to which he had given the manuscript name of *Monoptilota nubilella*. Owing to the unipectinate structure of the antennæ of the male (unique with the genus Ceara of Ragonot) the writer was at first in doubt as to the identity of the two sexes as one species, but this matter is now set at rest. As to the position of the genus, Dr. Hulst says that taking into account the most of its apparent affinities it may be placed after Phycitopsis and before Dioryctria, this position seeming to be indicated in some measure by Ragonot's Monograph.

The species may be known as the Lima-bean vine-borer.

THE SPECIES DESCRIBED.

The following description has been kindly furnished by Dr. Hulst, and although it has also appeared in the Canadian Entomologist of January, 1900 (Vol. XXXII, pp. 13, 14), it is deemed advisable to publish it entire here in connection with the illustrations. For the

benefit of those who have not given special study to the Microlepidoptera it should be said that of well-known moths this species bears a superficial resemblance to the genus Ephestia, which includes the Mediterranean flour moth and the still commoner though less troublesome dried-currant moth. It has, however, a more robust body; both pairs of wings are darker, the hinder ones more noticeably so and the pattern of the fore-wings is less distinct. The head is considerably larger and the male antennæ alone, as previously remarked, will serve to distinguish the genus from any other of the Phycitinæ. A female moth is shown twice natural size at *a*, the structure of the male antenna at *b*, fig. 1. The moth is subject to some variation as regards the markings on the wings, which are sometimes more suffused than in the specimen figured.

The wing expanse is about seven-eighths of an inch (21 mm. in the male; 23 mm. in the female).

TECHNICAL DIAGNOSIS OF THE GENUS MONOPTILOTA HULST.

Palpi ascending, second article heavy, third short; maxillary palpi small; front broad, flattened; ocelli not discernible in undenuded specimens; antennæ of ♂, first

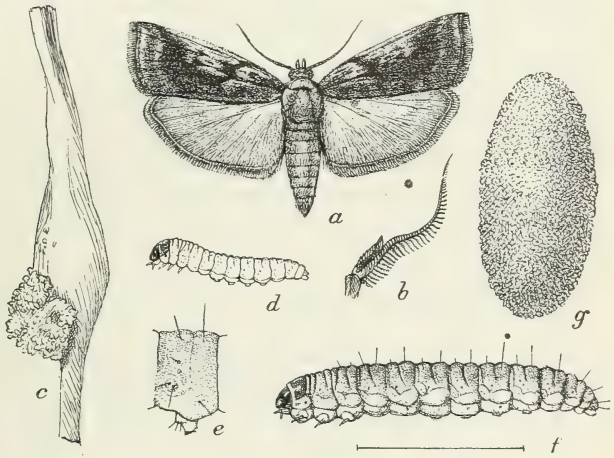

FIG. 1.—*Monoptilota nubilella:* *a*, female moth; *b*, antenna of male; *c*, gall of larva; *d*, young larva; *e*, first abdominal segment of same from side; *f*, mature larva; *g*, cocoon—all about twice natural size, except *b* and *e* which are much magnified (original).

segment much lengthened, swollen, followed by a decided, rather lengthened bend, hollowed on the inside into a deep furrow, or pocket, its entire length, the edges of the furrow scaled, becoming tufted on posterior edges outwardly; beyond sinus filiform; from beyond basal joint the antennæ are unipectinate, the pectinations one on each segment, filiform, being longest just beyond sinus and these five or six times the diameter of the stem, each armed with straight parallel hairs on each side; end segments ciliate. Antennæ of ♀ filiform, ciliate; thorax and abdomen rather stout, the genital armature of ♂ prominent. Fore wings rather elongate, subtriangular, 11 veins, 4 and 5 separate, 6 from cell near angle, 8 on 7, 9 and 10 from cell. Hind wings broad, 8 veins, 2 near angle, 3 from angle separate from 4, 4 and 5 stemmed half their length, 6 separate from 7; cell very short, not more than one-fourth wing length. Legs as usual in the group, rather heavy. (Hulst.)

TECHNICAL DESCRIPTION OF MONOPTILOTA NUBILELLA HULST.

Expands 21–23 mm. Palpi dark fuscous, lighter on inner side; front fuscous, much darker in front of eyes, and in one specimen purplish in middle; antennæ fuscous; thorax fuscous, with purple tint, more marked in front, and lightening into grayish behind; abdomen fuscous to light fuscous gray, somewhat purplish on anterior segments. All the segments darker lined; fore wings dark fuscous, broadly shaded with blackish longitudinally on veins, and lightened with white scales on anterior half and submarginally making these portions gray, with blackish dashes of ground color, the gray being most decided on subbasal and central anterior portion. Over the wings on the intervenular spaces is a purplish stain more evident posteriorly; cross lines faint, whitish, the inner shown mostly by the heavier dark angulate, somewhat diffuse blackish outer shading, the outer fine, rounded outwardly in middle with indistinct dentations; discal spots geminate, black; marginal line broken, black; fringe fuscous. Hind-wings dark, smooth fuscous, lighter basally and along inner margin, the lines darker; beneath even smooth fuscous, the fore wings the darker; marginal line blackish. (Hulst.)

DISTRIBUTION.

It seems probable, in spite of the few ascertained localities which we have concerning this insect, that its range extends well through the austral portions of Maryland, Virginia, and the District of Columbia, southward to Florida and Alabama, if not to a few neighboring Gulf States. It is obviously extremely local, and the abundance of individuals at Cabin John, Md., would appear to indicate that it perhaps extends some little distance farther north where the climate is suitable. At present it seems likely also that the species is a southern one and that it does not occur very far north in the Carolinian portion of the Upper Austral life area.

DESCRIPTIONS OF THE EARLIER STAGES.

The egg.—From a crippled female eggs were obtained August 16, but as they were not fertile and exceedingly variable in form a perfectly satisfactory detailed description was impossible. These were dull gray in color, irregularly oblong oval in form, and the surface was finely, distinctly, and rather regularly reticulated. The best formed specimens of egg obtained measured about 0.70 mm. in length by 0.40 mm. in diameter.

The young larva.—The youngest larvæ seen have polished, perfectly black head and thoracic shield; the body is dull light gray; the piliferous warts and a few dots showing distinctly on each segment, a little darker gray in color. The hairs naturally are longer in proportion and nearly white in color.

The larvæ between 10 and 12 mm. in length are darker, and those which have come under observation that are a little larger are dull green, darker above with dull carneous just beginning to show.

A young larva is shown in figure 1, at *d*, and an enlarged abdominal segment of the same in profile at *e*.

The full-grown larva.—The larva when mature is of striking appearance owing to the beautiful bluish-green color of the body. It is of robust cylindrical form, about five times as long as wide when extended, widest at the middle and tapering rather feebly till near the anal extremity. The general color of the body is glaucous or light sea-green (near verdigris green of Ridgway's nomenclature). The body is deepest in color, nearly blue on the ventral surface and in the thoracic region. The dorsal portion of the abdominal segments is darker and strongly marked as with an overlay, with dull carneous or pinkish. Segmentation is rather strong and the thoracic and abdominal folds are pronounced. The surface is rather sparsely clothed with rather long yellow hairs, short on the head and legs and longer elsewhere.

The head is a little less than half the greatest width, rather dark, nearly uniform moderately shining brown in color, becoming black near the trophi; inverted V-mark elongate, distinct. The first thoracic segment is a little narrower than the second and third; thoracic plate strongly transverse, moderately shining olive brown. Thoracic spiracle encircled with black; just anterior to this and a little below it is a small yellow chitinous patch of subtriangular shape, the apex directed obliquely slightly downward toward the head.

The first eight abdominal segments bear each a minute rounded piliferous wart on the side, smaller than, and located just above, the stigmata. Stigmata encircled with black. Last abdominal or anal segment strongly divided transversely, giving the impression of an extra segment. Anal shield weakly subtriangular, with the base rounded and the angles obtuse; color rather pale yellow, with margins marked with four fine black spots arranged like the corners of a rectangle. The three pairs of thoracic legs are well developed, as are also the four pairs of abdominal and the anal prolegs.

Length when full grown and extended, 21–22 mm.; width, 4.2 mm.

The mature larva is shown in profile in the accompanying figure 1 at *f*.

After the larva has spun its cocoon and is prepared for hibernation it undergoes a shrinkage, to about a third the size before its construction. Segmentation has become still stronger, and the body is now widest at the first and second thoracic segments. The colors have grown duller, the ground hue being green without the bluish tint.

The pupa.—The chrysalis or pupa is of robust proportions, and presents no characters worthy of special remarks. The color is rather dull olive brown, and the surface is moderately smooth and feebly shining in most portions except the wing-pads. These latter are nearly opaque, dull olive green, and reach in front to the bottom of the fifth

abdominal segment. The extreme tip is armed on each side with a minute spine, directed laterally and ventrally. Between these spines are four short, moderately coarse bristles. Length of specimen used in description, evidently male, 11 mm; width, 3.5 mm.

The cocoon.—Transformations take place in elliptical oval cocoons constructed of particles of earth or sand, joined rather firmly together by means of silk spun by the larva. One of these cocoons is shown at *g*, fig. 1. The average measurement is about 16 mm. long, and the diameter is about half that. These cocoons are usually formed in the immediate neighborhood of the infested plants, and such as have been observed were constructed close to the surface of the ground an inch or less below it.

The galls.—The galls at the time that the larva has reached full development measure about an inch to an inch and a quarter in length, that being the average length of the burrow of the larva within. In diameter they measure at this time about half an inch, but some have been seen later in the season that measured three-fourths of an inch.

The opening to a gall is usually made at one end, but occasionally near the middle, and of those seen a majority were placed at the lower end.

A gall with mass of exuding excrement is shown in figure 1 at *c*.

OCCURRENCE IN 1899.

Infestation was not noticed until July 8, but undoubtedly began earlier, when several vines were observed to be dying from within one to two feet of their tips, the leaves drooping over and slowly withering. Three or four holes were noticed on each of these vines, evidence that the parent insect had deposited three or four eggs upon each at rather regular intervals, and from these holes issued a small quantity of yellowish-white frass. The vines were in each case somewhat bent at the point of attack and some had already begun to assume gall-like proportions. Some of the vines were cut at this point and larvæ were found from a little less than a quarter to about half an inch in length. The largest burrows were at this time a little more than three-fourths of an inch long, one-eighth of an inch at the opening, and only about one-sixteenth in width, or just large enough for the easy passage of the larva up and down the vine.

The infested portions of vines collected July 8 were placed in a rearing jar and kept moist to prevent their drying. When examined July 17, one larva, about half grown, was noticed crawling about the jar. It was removed and placed in another jar with a fresh vine, and was found to have bored into this the following day. It is obvious, therefore, that the larvæ are capable of leaving an infested stem for another one as they crawl well and secrete a strong silk thread which readily supports the body, and thus they are able to let themselves

down without injury. Under ordinary circumstances, however, there is no necessity for a change of residence and there is no evidence that such change was voluntarily made during the season just passed.

July 25 and afterwards other visits were paid the infested bean patch, and by looking closely for fresh droppings upon the leaves, for gall-like swellings and dying and wilting leaves, a considerable number of the borers were secured that had escaped the first visit. When a well-formed gall results from borer attack it sometimes happens, particularly if the plant be well advanced in growth and the point of attack be low down upon the vine, that the plant does not appear to be in any great degree incommoded by the insect's presence, but it frequently happens on the other hand that the gall, if badly formed or made at a point where the plant is weak or weakly attached to the pole, becomes in time so broken open that the upper portion is killed. Several vines were thus found broken 4 and 5 feet from the ends. In one case a plant was observed that had lost three branching vines, all about 4 feet long and all bearing undeveloped pods.

From careful observations of all infested vines it was found that attack may take place at any point from the base of the vine on a level with the ground to within a few inches of the tip; that the result of attack varies greatly, a strong, well-grown plant being able to survive, while a weak one usually suffers in greater or less degree. As is so often the case with insect attacks, injury was much more noticeable at one end of the rows, the northern in this instance, than elsewhere, the southern end suffering somewhat less and the main portion of the planting still less. Attack had begun at the north end in the direction of the previous year's vines and ended at the southern or far extremity, since the larvæ matured much earlier in the vines at the former place than in the latter. One stunted plant attracted attention August 5. It was still green, but the leaves had all fallen away and there were no pods. It had been attacked two inches above the ground, and although the stem had not been severed, the plant had been practically a failure in consequence of the injury.

A few of the larvæ that were taken from the oldest parts of the largest vines were nearly full grown July 27, and by the beginning of the second week of August all but a few were mature, and some had escaped from the vines.

A mature larva was seen to leave its gall July 29, in the morning at about 11 o'clock. When the jar was next examined, at 2 o'clock the same afternoon, the larva had disappeared in the earth, and the following morning its cocoon was found attached to the stem in which it had lived, at the base, at the bottom of the jar.

Examination of the jar in which the other larvæ were confined showed that some had reached maturity and entered the earth a few days afterwards. One, however, was found August 1 which had just

molted, and was at this time only 3 mm. long. A majority of these larvæ would probably have left the vines before the middle of August.

From the observed fact that a bean vine if infested at all is usually attacked in two to half a dozen places, it is patent that a moth deposits several eggs on a vine before leaving it. In one instance two galls appeared about three inches apart.

As a rule only a single larva inhabits a gall, but one was found in which two were domiciled, one nearly grown, appearing to be the original habitant, and the other, less than half grown, an interloper.

THE SPECIES PARTIALLY DOUBLE-BROODED.

Two of the moths issued August 15 and these were all that were obtained that month from our rearing jars. One other moth issued September 7. Examination of the jars showed that they contained cocoons and when one of these was cut open, September 12, it was found to contain the larva.

The same day the writer visited the infested locality, finding that few larvæ still remained in their galls. It was also noted, as we had reason to expect, that a second generation had begun to attack the plants.

The second generation about the District of Columbia is a very small one, the majority of the first generation wintering over, probably as larvæ, as several species of insects are known to do here. In short, the species is only partially two-brooded, in this respect resembling the squash-vine borer and certain chrysomelid beetles, which are not fully double-brooded in this locality.

Farther north, if the species extends toward the Transition zone, which seems doubtful, there would be without doubt only a single generation, and southward in the Lower Austral we may be equally sure to have two well-defined generations each year.

A larva obtained in the field September 14, and undoubtedly of the second generation, required about a week longer to complete its growth and was found spun up September 26.

It is evident that the second generation is able to complete its development before the crop is made.

NATURAL ENEMIES.

The first generation of this insect appeared to be absolutely free from the attack of any natural enemies, either parasitic or predaceous, none of the galls harboring any other insect than its original occupant. In galls produced by the smaller generation a single parasitic pupa was found in September. This transformed to adult on the 4th of that month, and the specimen on being referred to Mr. Ashmead was identified as *Omphale livida* Ashm., originally described from Florida.

REMEDIAL MEASURES.

This insect could be kept in check by trimming and destroying the terminal vines when these are found to be infested, while the larvæ in the lower portions of the stem could be removed by cutting longitudinally without serious injury to the stem itself. This latter measure was employed by the writer to obtain specimens with comparatively little injury to the plant itself, and certainly with less than would have been accomplished by the larvæ had they been left until maturity in the stems. Such methods are, of course, irksome, but there is no other recourse, as insecticides can not be applied so as to reach the insect without an equal amount of labor. After the crop is gathered, harrowing the plats where the plants were growing in the fall would tend to expose the larvæ or pupæ to the elements, and then plowing deeply in the spring would have the effect of preventing the moths from issuing. This remedy has been tried against the squash-vine borer with success, and there can be scarcely any doubt that it would be productive of equally good results with the present species.

THE SMALLER CORN STALK-BORER.

(*Elasmopalpus lignosellus* Zell.)

Since the first recorded injurious occurrence of the so-called smaller corn stalk-borer in the Southern States in 1881, the species was not reported to be again troublesome, to the writer's knowledge, until the past year, 1899. Neither has it to our knowledge been previously observed to attack any other plant than corn, nor has it been recorded from Alabama, in which State attack came to notice during the year.

The notes which follow, concerning recent injury, show a much wider range of food plants than the species was formerly known to have, and imply some doubt as to whether corn or other Gramineæ are its original or preferred food plants.

REPORTS OF INJURY.

August 16, 1899, we received from Prof. F. S. Earle, Auburn, Ala., larvæ of this species in stems of young beans. The larvæ were in all cases found in that portion of the stalk below the surface of the earth, a hole showing near, apparently just at, the surface through which the larva had forced its excrement and in many cases made its escape before reaching us, as only a small proportion of the stalks sent contained larvæ. From this sending were obtained moths which began issuing during the last day of August and the first part of September. Concerning injury, Professor Earle wrote under date of August 29

that less than 10 per cent of the stand of beans from which the infested stalks were taken were left on the plat where infestation was noticed. No larvæ could be found at that time.

September 25, Mr. Thomas I. Todd, Athens, Ga., sent specimens of larvæ, with the report that they feed in growing peanuts and had destroyed in his vicinity a great many plants, sometimes as much as half a crop. The specimens when received were partly in the shells of the nearly mature nuts or tubers.

September 27, Mr. H. M. Simons, Charleston, S. C., sent larvæ, together with specimens of the stalks of snap beans showing injury done by them. The species was described as attacking beans at all stages of growth, from the time that the plant appears above ground until it comes in full bloom, and injury had been noticed even when the plants were fully mature and the beans nearly ripe.

October 2, Mr. Todd included a specimen of this larva in a sending of various species found eating the leaves of turnip. The larva was spun up at the side of the midrib of a leaf, being partially concealed in a web, and overnight ate a very considerable quantity of the leaf. Concerning its occurrence in peanuts, he wrote, in response to inquiry as to whether the proximity of corn did not have something to do with the attack, that the peanut patch where the larvæ were first observed was at least 200 yards from any corn, and that no corn had been planted nearer the previous year. Inquiry of his neighbors brought out the information that peanuts that were planted between each hill of corn were very little more subject to attack than where the peanuts grew distant from cornfields. Our correspondent also failed to find any corn that was infested. Larger borers, however, were found in the stalks, presumably either the corn ear-worm or the fall army worm.

DESCRIPTIVE.

The moth which produces this borer is a member of the family Phycitidæ, and until recently was known in most works as *Pempelia lignosella*, but is now referred to the genus Elasmopalpus of Blanchard. It is an exceedingly variable species, but typical specimens resemble rather closely the forms illustrated in figure 3. The moth measures about three-fourths of an inch in wing expanse, the females being usually larger. There is great difference in the two sexes, so great in fact that in ordinarily well-marked specimens the sexes look like distinct species. Besides the differences in antennal structure, which can at once be seen by comparison of the two figures (*a* representing the male and *b* and *bb* the female), the male palpi are longer and thicker. Pale yellow or ochreous is the prevailing color of the fore-wings of the males in well-marked individuals. This is bordered out-wardly, particularly at the ends, with dark purplish scales, forming a pattern

more or less like that represented in the figure of the male here presented, there being great variability as to the extent of the ground color and the border. In extremely dark individuals the ochreous is scarcely apparent save in a small portion of the middle of the wings.

In the females the wings are entirely reddish, purplish, or plumbeous, and in some cases nearly black. The head and thorax are usually light in the male and of the same color as the wings in the females. The abdomen in both sexes is gray. The hind-wings are transparent, light silvery fuscous, with a rather strong subbasal line on the inner margin of the cilia. The peculiar structure of the antennæ and mouth-parts of the male is mentioned somewhat in detail with enlarged figures in the report of the Commissioner of Agriculture for 1881. A portion of these have been adapted to figure 2, here reproduced. The variability of the species is shown by the different synonyms founded on colorational differences. Of these, *angustellus* Blanch. agrees with the type; *incautellus* Zell. differs in having the central portion of the fore-wings bright reddish; while *tartarellus* Zell. has the fore-wings plumbago or blackish.

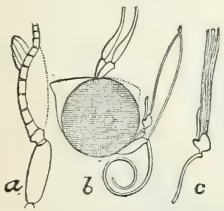

FIG. 2.—*Elasmopalpus lignosellus: a*, base of male antenna, dotted lines indicating outline of scales; *b*, head of male with mouth parts denuded; *c*, maxillary palpus of male—all greatly enlarged (after Riley, Rept. Dept. Agr. 1881).

DISTRIBUTION.

The original specimens of this species accompanying the first reported injury in the United States were received from Richmond County, Ga. The species was reported the same year at Atlanta, Ga., and Columbia, S. C., and as far north as Chapelhill, N. C. In the National Museum collection we have also specimens from Eufaula, Ala., Archer, Fla., Kansas, and Texas, the last State being represented by material from several sources, in all probability from as many localities.

Zeller recorded this species from Texas, and Dr. Hulst (Tr. Am. Ent. Soc., Vol. XVII, p. 159) added Florida, with the additional statement that it had been taken in the Bahamas, Venezuela, Buenos Ayres, Patagonia, and Chile. Zeller also records Colombia and Brazil.

It is evident from this that the species is of southern origin, obviously tropical, and perhaps introduced from the West Indies into subtropical North America. As no very extensive injury has been recorded since its original discovery of establishment as an enemy to agricultural interests, now nearly twenty years ago, it seems probable that there is very little immediate danger of serious injuries or of the insect's spreading much farther north than where it has been reported to occur in North Carolina; although this may be accomplished in time. The past year Mr. Aug. Busck obtained a perfect moth at Bladensburg, Md., in August, and Mr. F. M. Webster observed

this species several years ago at LaFayette, Ind. These captures, however, do not evidence the permanancy of the species in those localities.

THE EARLY STAGES OF THE INSECT.

The larva.—The larva is nearly cylindrical, upward of half an inch long when mature, and a beautiful object when viewed through a hand lens, pale green in color, marked above with nine reddish-brown longitudinal stripes arranged in transverse bands, forming on the different segments the patterns shown in figure 3 at *d*.

It is of elongate subcylindrical form, moderately depressed on the dorsum and a little more ventrally, and upward of eight times as long as wide. The general color above is in life pale bluish green, and the venter is paler green tinged more or less strongly with carneous. The blue and green colors fade in inflated specimens and in alcohol. The head is small, considerably narrower than the first thoracic segment,

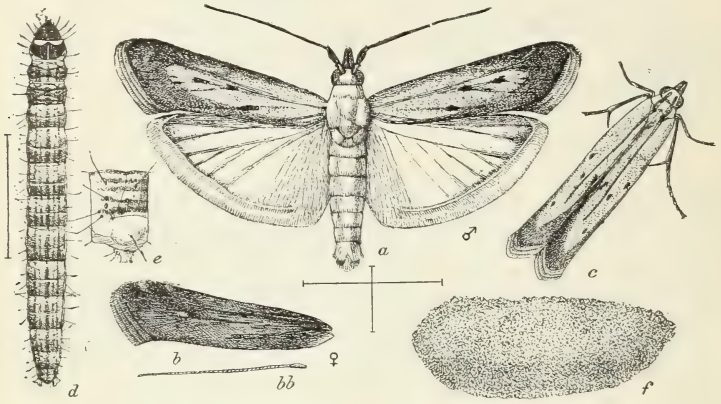

FIG. 3.—*Elasmopalpus lignosellus: a*, male moth; *b*, fore-wing of dark female; *bb*, antenna of female; *c*, male at rest; *d*, larva; *e*, ventral segment of larva from side, much enlarged; *f*, cocoon—all except *e* three times natural size (original).

and shining moderately dark brown in color. Prothoracic plate very dark brown, nearly black, polished, with the median line narrow but distinct. The thoracic segments are deeper bluish green than the abdominal, this color and the lighter abdominal ground color showing only near the sutures, where it forms in the anterior portion of each segment a transverse band, appearing at a little distance to be only about a fourth as wide as the remainder of each segment, but in reality (by closer inspection) fully a third of the whole segment. Segmentation is not pronounced, but the segmental folds, as seen from the side, are moderately prominent. Surface sparsely covered with moderately long hairs. Anal segment darker than the other abdominal segments, but scarcely with a pronounced shield as in many larvæ.

Length, 15 to 16 mm.; width, 1.8 to 2 mm.

Transformation to pupa takes place in a tolerably compact cocoon formed in the earth and covered with grains of sand or dirt. Such as have been seen were elongate, nearly reniform or bean-shaped, acutely prolonged at each end, and measured, when divested of such particles of sand or dirt as did not adhere closely, from 12 to 14 mm. in length and about 6 mm. in width. A cocoon is shown at *f* of figure 3.

LITERATURE.

During the year 1881 this species was the subject of some study on the part of Dr. Howard, as also of Dr. W. S. Barnard, at that time connected with this office. Among other things it was learned that it had never been noticed in this country prior to 1878 (Rept. Comm. Agr. for 1881, pp. 142–145). Brief mention of this stalk-borer as an enemy of corn has been given by Prof. L. Bruner in his report to the State Board of Agriculture of Nebraska for 1891 (p. 260), and this sums up all that the writer is able to find that bears in any way upon the biology of the insect. A rather full bibliography is given by Dr. Hulst (l. c.).

Figure 4 shows the nature of the work of this stalk-borer in corn.

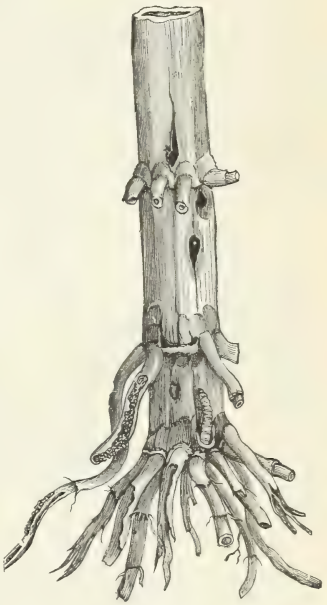

FIG. 4.—Corn stalk showing work of maller corn stalk-borer—natural sizes (after Riley, Rept. Dept. Agr., 1881).

NATURAL ENEMIES.

Until the past year no natural enemies of this species had been observed, to our knowledge. From larvæ received from Mr. Todd, Athens, Ga., a hymenopterous parasitic larva issued October 15, and four days later was found to have transformed to a naked pupa, the adult issuing early in November. It has been identified by Mr. Ashmead as *Orgilus* (*Microgaster*) *mellipes* Say.

REMEDIES.

Previous observations have shown the practical impossibility of a perfect remedy for this insect, since it has been observed to hibernate in all three stages of larva, pupa, and adult.

Only two remedies suggest themselves: The plowing up and burning of the corn stubble or other infested material as early as possible after the crop is made, as already advised in the 1881 report, and rotation with some crop not affected by the species. It seems probable that this insect would not injure any of the smaller cereals, sweet potatoes, cotton, melons and other cucurbits, potato, tobacco, and

other solanaceous crops, asparagus and other vegetables, and this suggests the use of the small grains and the other field and garden plants as alternate crops. It is not likely that the insect could be reached with insecticides.

THE PALE-STRIPED FLEA-BEETLE.

(*Systena blanda* Mels.)

The frequency of the occurrence of the little flea-beetle, *Systena blanda* Mels., on cultivated crops in recent years, as shown by published record as well as by personal experience, has led the writer to look carefully through our literature and our divisional notebooks and to make such observations as have been possible toward a completion of our knowledge of the species. In the vicinity of Washington, D. C., the beetle has been noticed most often in connection with observations on the insect enemies of beans, but the larva has not been found on, and may not live at the expense of, this plant. The beetle is more often associated with corn than with any other crop plant, and the larva, although on one occasion found upon corn, without doubt feeds normally on certain common species of weeds, one of which was positively identified during the past season, while a second is more than probable. The still more common occurrence of the beetles on certain other forms of weeds indicates these as also larval food plants.

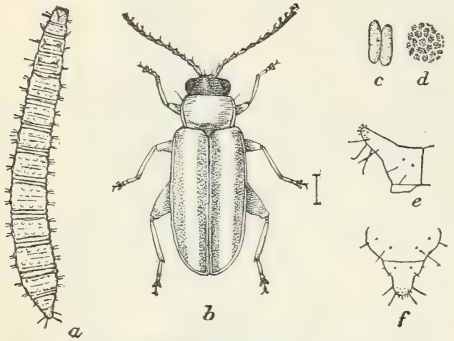

FIG. 5.—*Systena blanda*: *a*, larva; *b*, beetle; *c*, eggs; *d*, sculpture of egg; *e*, anal segment, from side; *f*, same from above—*a–d*, six times natural size; *e*, *f*, much enlarged (original).

DESCRIPTION OF THE ADULT.

The beetle known as *Systena blanda* measures about an eighth of an inch (3–2.5 mm.) in length and is about a third as wide as long. It is cream colored, with nearly black abdomen and eyes, and the elytra are ornamented with a broad sutural and two narrower marginal stripes of a dull, light-brown color.

Not infrequently the elytral stripes are obsolete. The head is reddish, the long, slender antennæ and the legs also marked with light brown, and the posterior femora are greatly enlarged like those of other flea-beetles. It resembles superficially the common cabbage flea-beetle (*Phyllotreta vittata*), but is much larger. The colors specified apply to the typical *blanda*, which is represented at figure 5, *b*.

Everything considered, this is perhaps the best-known species of its genus, from the frequency of its attacks on cultivated crops. The term species is used for convenience. Up to the year 1889 *Systena blanda* was considered to be a distinct species. In that year, however, Dr. Horn, in his Synopsis of the Halticini of Boreal America (Tr. Am. Ent. Soc., Vol. XVI, p. 273), relegated this form to varietal rank, placing it as a synonym of *S. tæniata* Say. It is not within the province of this note to discuss the validity of *blanda* as a species, nor dispute the opinion of our greatest authority on American Coleoptera. The question is largely one of opinion, and for present purposes at least *tæniata* and *blanda* may be considered distinct. A common form of *tæniata* is shown at figure 6. It is polished black with white stripes, having the same superficial appearance as *elongata* Fab., a common Eastern form. The references to published literature which will be cited pertain only to accounts in which *blanda* is either specifically mentioned or known to have been the species under consideration.

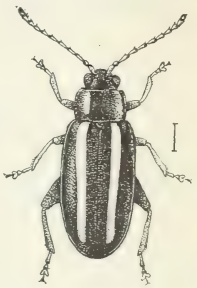

FIG. 6.—*Systena tæniata*, dark variety—about 6 times natural size (original).

DISTRIBUTION.

Systena blanda is a native American species, and was first described by the younger Melsheimer from Pennsylvania (Proc. Acad. Nat. Sci. Phila., Vol. III, p. 164) in 1847.

The distribution accorded by Horn includes "New England" and Pennsylvania to "Dakota," Kansas, Colorado, and New Mexico. It has been observed in the greatest abundance, according to available data, in New Jersey, eastern Pennsylvania, Maryland, Ohio, Indiana, Illinois, and Nebraska. Injuries have also been reported in Virginia, Georgia, Delaware, Michigan, and Arkansas.

The following list of localities is for the most part derived from material in the National Museum, and particularly from specimens in the Hubbard and Schwarz collection, and from the collections of the writer and Mr. Pratt, but includes also a number of recorded localities not represented by specimens:

"New York" (exact locality unknown); Cape May, Spring Lake, and Washington, N. J.; Allegheny, Chambersburg, and Kennett Square, Pa.; Newark, Del.; Marshall Hall, River View, Seat Pleasant, and Travilah, Md.; Colonial Beach, Woodstock, Rosslyn, Fortress Monroe, and Pennington Gap, Va.; Adrian and Monroe, Mich.; Champaign, Anna and northern Illinois; Chesterton, Columbia City, Paxtons, Sumner, and Tippecanoe County, Ind.; Lincoln, Nebr.; Harrison, Ark., and Jackson County, Ga. Specimens identified and labeled "blanda" are also present in the national collection from Winslow,

Tucson, and Yuma, Ariz.; Salt Lake City, Utah; La Veta, Colo., and California.[1]

Although the above localities show a wide distribution east and west and southward from Pennsylvania and New Jersey, the species is, on the whole, somewhat peculiarly Carolinian, at least as regards reported injuries. It has never been found, at least to the writer's knowledge, near New York City, and its occurrence in the Austral portion of New York State is doubtless rare. The exact locality in New England does not appear to be known, but it is not improbable that it is Connecticut, which includes a considerable strip of Carolinian territory. The species is evidently rare in the upper portion of the Carolinian region, and not common in the Austroriparian, if indeed it occurs there at all.

DESCRIPTIONS OF THE EARLIER STAGES.

The egg.—The egg is elliptical but somewhat inconstant in outline, about two and a half times as long as wide, and opaque, light buff yellow in color. The sculpture of the surface, as observed under a moderately high power of microscope, appears to be granulated, but under a higher lens it is seen to be divided into very minute and rather ill-defined shallow concave hexagonal areas arranged in sevens inclosed in hexagons. Length, 0.60 to 0.68 mm.; width, 0.25 to 0.27 mm.

The eggs are shown enlarged at *c*, fig. 5 and the sculpture at *d*.

Eggs were laid from June 10 to July 8, and all that were observed were deposited singly and in small masses of three or four, flat upon the leaves or attached to the sides of the tubes in which the beetles were confined.

The larva.—The larva is white and slender, resembling superficially Diabrotica and Epitrix, whose larvæ have been figured in previous bulletins of this series. The head is light brownish yellow and the legs are pale yellowish and faintly lined with dark brown at the articulations of the joints. The legs resemble those of Epitrix, ending in blunt padlike processes. The dorsal surface of the body is somewhat peculiar as regards the tubercles. These are so nearly obsolete as to render it difficult to locate them with certainty. Their arrangement is only approximately indicated in the illustration (fig. 5, *a*).

[1] A very considerable proportion of these last-mentioned specimens have the sutural and lateral stripes black. Most of the individuals thus marked fall into varieties *mitis* and *ligata*, and may be considered *tæniata*. In other words, I have reserved the term *blanda* to apply more particularly to such forms of *tæniata* Say (Horn) as occur in the eastern portion of the United States (mostly in the Carolinian life area, although *blanda* appears to extend somewhat into the Upper Sonoran), while *tæniata* is reserved for those other very variable forms, such as *mitis* and *ligata*.

There is every probability that the form found in Colorado, Arizona, and New Mexico extends into Central America, as a species of Systena has been described by Clark under the name of *pectoralis*, which is, according to Jacoby, "perhaps identical with *blanda* Melsh." This latter form is generally distributed in Mexico and other States of Central America.

The most striking feature of the larva is, perhaps, the anal segment, which tapers to a conspicuous prolonged process, surmounted at the apex with a crown of short spines and four long stiff spinose hairs. This segment is shown enlarged, dorsal view, at *f*, while the lateral view (*e*) shows also the anal proleg. The surface of the body is moderately hairy, the hairs of varying length.

The length of the larva when full grown is about 3 mm., the width about one-eighth of that.

A somewhat more technical description of the larva is given by Mr. John Marten (Forbes's 18th Ills. Rept., 1894, p. 22).

The pupa.—The pupa also resembles those of Epitrix and Diabrotica, being of the same general appearance and having the anal segment ending in a pair of spines, described by Marten as brown, rather long, tapering, and very thick at the base. Length, 3.5 to 4 mm.

RECENT UNRECORDED OCCURRENCE OF THE SPECIES.

This flea-beetle was first observed on beans during the first two weeks of August, 1897, at Marshall Hall and Seat Pleasant, Md., eating the epidermis from the upper sides of the leaves, and was noticed in less numbers on bean leaves the following years. The first record of serious damage to beans which can be found is that of F. M. Webster (Insect Life, Vol. VI, p. 186), who states that it was very destructive to beans in Ohio in 1893, and that "large fields were seriously damaged."

In 1898 the species was quite abundant upon its wild food plants, and particularly noticeable by its occurrence on the pigweed, *Ambrosia artemisiæfolia*. That year at River View, Md., it occurred in such abundance as to outnumber any other species of beetle that could be obtained with a sweep net.

June 30 Mr. F. J. Dickinson, Chesterton, Ind., sent specimens, with the report that the species was causing much alarm through the neighboring country, and that the beetles appeared on a great variety of plants, but seemed to be doing the most damage to the potato.

July 5 the beetles were found at Colonial Beach, Va., in numbers on the cocklebur, *Xanthium canadense*, eating the leaves from the upper surface, and in this locality at least preferring this plant as food to the *Ambrosia artemisiæfolia*, which grew in the immediate neighborhood.

July 9 Mr. Dickinson wrote in response to inquiry that this species was injurious to melons and other cucurbits, turnips and other cruciferous plants, eggplant, beans, tomato, and potato, the last crop being the one that was most seriously damaged in that vicinity.

In 1899, Mr. Edwin C. Post, Monroe, Mich., under date of June 23, sent specimens, with the information that the species occurred in a sugar-beet field, presumably in that vicinity, which had been practically destroyed by them. They were described as quite active, jump-

ing about like fleas, and were found on only one other plant, specimens of which were inclosed and which proved to be *Ambrosia artemisiæfolia*.

The same year the species was to be found in its usual abundance upon the weed last mentioned, as also upon the black or garden nightshade (*Solanum nigrum*). July 1 it was observed on beans and upon Lima beans at Cabin John, Md.

July 11 and 12 Mr. Pratt, on the occasion of a visit at Travilah, Md., made a special search for the larva, with the result of finding a few individuals at the roots of lambsquarter, *Chenopodium album*, and Jamestown weed, *Datura stramonium*. The imagos reared issued July 22 and 23.

In a previous year the writer captured an adult near Washington, June 17, which had but just issued, being still immature at this time.

PUBLISHED ACCOUNTS OF FOOD HABITS AND INJURY.

What is evidently the first account of the habits of this species was published by Townend Glover in the Monthly Report of this Department for July, 1873 (republished in Ann. Rept. 1873, p. 152). In June of that year it was reported at Chambersburg, Pa., where it had "nearly devastated a field of corn, eating the leaves and leaving the bare stalks standing." In 1878 or 1879, according to Dr. Cyrus Thomas (*cf.* Webster), this insect "ravaged fields of growing corn in Illinois."

Other accounts containing information concerning the habits of this species may be briefly mentioned. In 1884 Dr. S. A. Forbes (13th Rept. Ins. Ill., 1883 [1884], p. 86) published a brief notice of its abundance on the leaves of strawberry and melon near Anna, in southern Illinois. In 1886 the same writer mentioned the rearing of its larva from kernels of sprouting corn in the earth (Can. Ent., Vol. XVIII, p. 177) and the feeding of the imago on the cocklebur, *Xanthium strumarium* (Ent. Amer., Vol. II, p. 174). In 1887, according to Mr. F. M. Webster, it occurred on potato vines in Tippecanoe County, Ind. (Indiana Farmer, July 30, 1887; Rept. U. S. Dept. Agr., 1887, p. 151). The same year Dr. J. A. Lintner recorded it on cotton in Jackson County, Ga. (Count. Gent., Vol. LII, 1887, p. 441; 4th N. Y. Rept., 1888, p. 155). In 1890 Mr. Webster again reported injuries at Lafayette, Ind., to beets (Tr. Ind. Hort. Soc. for 1890 [1891], p. 26.) The following year Mr. Lawrence Bruner included this species in a list of the insects observed in Nebraska attacking the sugar beet. White clover, purslane, and Amaranthus are also cited as food plants, and the opinion was expressed that this is liable to be one of the most destructive beet insects in the West (Bul. 23, Div. Ent., p. 15). He also treats of the species somewhat more at length (Bul. 16, Nebr. Agr. Expt. Sta., 1891, p. 60) in its relation to sugar beet, adding Chenopodium to the list of the food plants of the beetle, and remarking that it fed sparingly on the Cruciferæ.

The species mentioned by J. F. Wielandy in Insect Life (Vol. III, p. 122) as having been "very pestiferous" to various plants in 1890 at Santa Fé, N. Mex., and particularly to "Yosemite Mammoth bush beans (costing one-half a cent a bean)," is probably *blanda*, but the specimens received on that occasion are not, at the time of writing, available for identification.

In 1893 Dr. J. B. Smith reported it in great abundance in the southern and central counties of New Jersey. Near Bridgeton, June 26, "it had almost entirely destroyed every field of carrots," the injury being to young plants as soon as they appeared above the surface. The leaves of young beets were infested, "melons of all kinds were also attacked, and in one field of cantaloupes the injury done by these creatures exceeded the injury done by the striped beetles," *Diabrotica vittata*. Corn, purslane, and pigweed were also infested. In previous years the same writer had noted injury by this species to beans near Washington, N. J. (Rept. Ent. N. J. Agl. Coll. Expt. Sta. for 1893 [1894], pp. 478–480.)

In 1894 Dr. Forbes publishes the first account of the biology of this species, giving descriptions (by John Marten) of the larva and pupa and figuring the former.

Finally, in 1899, Prof. W. G. Johnson, of the Maryland Agricultural Experiment Station, reported this species to be injurious that year, the first report having reached him May 2, to Kieffer pear grafts. Damage was stated to be serious, and was accomplished by the beetle's eating out the terminals, thus stunting the growth of the trees. June 1, the same year, the species was reported to Professor Johnson as having destroyed 40 acres of tomatoes in Dorchester County, Md., injury being described as widespread, serious damage having been done in the Eastern Shore counties (Bul. 20, n. s., p. 63).

EARLY DIVISIONAL RECORDS.

Complaints of damage to the blades of corn have come to the Division from other sources than those published. Among these a few may be mentioned. Reports were received, with specimens, from John W. Spencer, Paxton, Sullivan County, Ind., dated June 22, 1885; from R. F. Smith, Columbia City, Ind., who stated that the species was "doing considerable damage to growing corn and oats," June 20, 1895; from B. F. Ferris, Sumner, Ind., reporting that this flea-beetle was "destroying the leaves of young corn as soon as they appear, thereby killing the plants."

The writer observed the beetles in some abundance the second week of June, 1891, at Kennett Square, Pa., eating the blades of corn and the leaves of *Ambrosia artemisiæfolia*, which grew between the rows of hills.

Of injury to other crops the following reported instances are worthy

of mention: July 23, 1886, Mr. E. W. Allis sent specimens of the beetle to this office, with the accompanying information that the species had been very destructive to early sugar beets that year at Adrian, Mich. A neighbor, Mr. H. C. Bradish, was also much annoyed with this beetle. Our correspondent noticed the abundance of the beetles on "hogweed," presumably *Ambrosia artemisiæfolia*. June 21, 1891, the species was received from Mr. M. H. Beckwith, Newark, Del., with the report that it was injuring the leaves of potato. May 25, 1893, Mr. J. G. Taylor, Harrison, Ark., sent beetles with the statement that they were injuring pear leaves, eating them partially, so that they colored and dried up. The damage was most apparent on young budded nursery stock of that spring's growth. The beetles were to a lesser extent injurious to foliage of young apple trees.

There are also specimens in the National collection labeled "on peas," and others "on peanuts," but without locality. There is also a note referring to the last specimens, stating that the beetles were destroying peanuts. The locality in the last case is probably St. Louis, Mo.; the date June, 1874.

PROBABILITY OF A SECOND GENERATION.

Adults have been taken by the writer in numbers as late as September 17 in past years in central New Jersey, and this late occurrence of the beetles, taken together with their observed issuance as early as the middle of June, has disposed the writer to the belief that there is probably a second generation of this species in a latitude like that of the District of Columbia, although an experiment that was made for the purpose of testing the matter met with negative results.

July 28, 1899, a considerable number of beetles were placed in a large rearing cage with a healthy potted plant of *Ambrosia artemisiæfolia*. It was examined about a month later and no trace of larvæ could be found, but the plant had begun to wither at this time. Although this is not conclusive evidence that there is not a later generation of *S. blanda*, it is significant as indicating the probability that the insects do not deposit eggs ordinarily after the end of July.

SUMMARY OF LIFE HISTORY.

From what has been recorded it is obvious that there is much to learn before we know even approximately the life history of this species, as, for example, when it makes its first appearance and begins egg laying, how and where the eggs are deposited, the period of ovulation, a full list of the larval food plants, and whether the species is single or double brooded.

At the present time we know that the species hibernates as a beetle, and appears above ground in this vicinity early in June; that egg

laying continues probably through that month and at least to the middle of July, if not two or three weeks later; that injury is due to the beetles upon their first appearance usually; and that almost any valuable crop may be injured, either in the absence or presence of the wild food plants; that the larvæ feed below ground, and probably have a wide range of host plants in addition to those which have been ascertained, which include at present only corn, lambsquarter, and probably Jamestown weed.

NATURAL ENEMIES.

Neither predaceous nor parasitic insect enemies have been observed of this species. The writer is under obligations to Dr. Sylvester D. Judd, of the Division of Biological Survey, for information concerning certain of its vertebrate enemies. During June and July, 1898, he observed two species of sparrows in wheat fields near Marshall Hall, Md., feeding upon the adult flea-beetles, which were at the time on *Ambrosia artemisiæfolia* growing between the rows of wheat. The chipping sparrow (*Spizella socialis*) was observed June 16 and 17, and specimens were shot and their stomachs examined. Eight of these contained individuals of the flea-beetle as follows: 8, 12, 5, 7, 8, 6, 12, and 14 specimens in each. The grasshopper sparrow or yellow-winged sparrow (*Ammodramus ravennarum passerinus*) was observed attacking this flea-beetle July 9.

REMEDIES.

Dr. Fletcher has reported finding that Paris green applied dry, mixed with twenty parts of flour and dusted on the infested plants, was thoroughly effective against this insect, and Professor Bruner obtained equally good success by the use of kerosene emulsion. The arsenites suggest themselves as the appropriate remedy, and, since Bordeaux mixture has been found to be particularly distasteful to flea-beetles, this substance, if mixed with Paris green and applied as a spray, should prove still more valuable than when used dry. Keeping down the weeds which are known to be, or which we have good reason to believe are, larval food plants, such as lambsquarter, cocklebur, pigweed, etc., should also be productive of good results. A good time for the destruction of these weeds would be about the middle of July, when most of the beetles have laid their eggs, and the larvæ have not yet attained full development. By pulling up and burning the weeds at this time the larvæ could be destroyed in great numbers.

Although the species is still periodical in its attacks, it is by no means certain that it will not prove injurious in some localities for two or more years in succession.

OBSERVATIONS ON THE BEAN LEAF-BEETLE.

(*Cerotoma trifurcata* Forst.)

Our knowledge of the life history of this species while not entirely complete, is so nearly so that no special effort has lately been made to learn more concerning it. Nevertheless a few facts have been observed and reported which are deserving of record. Among the cases of reported injury in 1899 that will be cited are some of unusual severity, a circumstance of some interest, since it bears out the prediction made by the writer two years ago (Bul. 9, n. s., p. 64) that the species was obviously increasing in abundance and injuriousness and liable to become a pest to the bean crop of the central Atlantic portion of the United States.

Injurious occurrence in Virginia and northward.—The species was as abundant in 1899 in the localities visited by the writer in and near the District of Columbia as in the two previous years.

May 30, 1899, specimens of the beetle were brought to this Division by Mr. George G. Hill, who stated that the insect was doing considerable damage to young beans at Falls Church, Va.

About the same time Dr. S. D. Judd reported the species in great abundance, and injurious to beans about a foot high, in the vicinity of Marshall Hall, Md.

June 5 we received word through Mr. E. B. Calvert, of this Department, that this species, a specimen of which was received, was doing much damage to string and Butler bean vines at Petersburg, Va.

June 6, Mr. E. M. Wright, Eureka, Ill., observed this species, which he identified from the description and illustration given in Bulletin No. 9, on wax beans in his vicinity.

Injurious occurrence in Alabama.—June 15 we received specimens of the larva from Mr. F. S. Earle, Auburn, Ala., together with affected bean stalks which were believed to be injured by it. The insect was described as an old offender. Writing under date of July 4, our correspondent stated that this species had been excessively abundant that year and had practically destroyed all the early plantings of beans; those planted after the middle of May, however, escaped injury. The beetles were described as being on hand, waiting for the plants to come up, and when the ground was cracked open by the seedlings the beetles went down and injured the minute plants badly before they could get above ground. In this respect injury resembles that so well known as being caused by the striped cucumber beetle, *Diabrotica vittata*, to cucumber and other cucurbits. The crop was sprayed three or four times with Paris green, but this did not save it.

Accompanying Mr. Earle's first letter were specimens of the roots and subterranean stems showing work both of the larva and of what

our correspondent described as four different kinds of serious fungus enemies, which considerably complicated matters. Early plantings of cowpea were said to have been injured almost as badly as beans. It was stated also, among other things, that farmers in north Alabama no longer attempted planting cowpeas before June on account of the injuries attributed to this insect. Velvet beans were growing side by side with beans in plots on the Experiment Station grounds at Auburn, Ala., and the former appeared to be entirely free from attack, while the latter were badly injured. Exemption from attack on garden pea had been noticed here as elsewhere.

Occurrence in other localities.—Among new localities where attack on bean was observed during the year were Alexandria, Va., Travilah, Md., and Louisiana, Mo. In the locality last mentioned, attack was reported by Mr. G. M. Dodge in a letter dated November 24.

At Bay Ridge, Md., the work of the beetle was evident on hog peanut, *Falcata comosa* (*Amphicarpæa monoica*), and although the larva was not found on this plant, the fact that no other known larval food plant or other plant, affected by the beetle grew in the vicinity is additional evidence that this is a true host plant of the larva. Beetles taken at this time on the vines deposited eggs July 25.

Early and late occurrences.—One observation on the occurrence of the bean leaf-beetle near Washington was the appearance of a newly transformed beetle June 30, which is nearly two weeks earlier than observed in 1897.

Beetles were taken as late as September 15, on which date considerable injury was noticed on the young terminal leaves of Lima bean at Cabin John, Md.

NOTES ON THE IMBRICATED SNOUT-BEETLE.

(*Epicærus imbricatus* Say.)

This species, which was treated somewhat fully by the writer in Bulletin 19, n. s. (pp. 62–67), has since come under observation on several occasions, having been studied in connection with insects affecting beans and peas.

Adults were observed July 8, 1899, feeding upon bush beans at Cabin John, Md., and two days later Mr. Pratt found the beetles at Travilah, Md., eating blossoms of Lima bean. All of the beetles seen at this date were badly rubbed and such as were kept died a week or two later, none remaining after the third week of July. July 29, 1899, a newly transformed beetle, as its bright color indicated, was taken on the foliage of tick trefoil (*Meibomia* sp.).

Although the life history of this species is incomplete, we have the principal data, with the exception of the most important—the larva and pupa and larval food plant. The above observations show that the

beetles of the new brood may appear within at least a week or two from the time of the demise of the hibernated parent beetles.

During the second week of August a fungus was noticed to be growing upon a specimen of this snout-beetle in our rearing jar, and was kept until it appeared to be fully developed, when a sketch which accompanies this note was made. The infected insect was referred to the Division of Vegetable Physiology and Pathology, and the fungus was identified by Prof. B. T. Galloway as a species of Sporotrichum, very close to, if not identical with, *S. globuliferum*. In the letter of transmittal the writer expressed the opinion that the death of the insect might be due to fungous attack, an opinion in which Professor Galloway concurs, since he writes that the fungus is an active parasite on many other insects, and there is therefore little doubt that it was the cause of the beetle's death. Attention is called to the bisymmetrical arrangement of the fungous growth upon the body of the insect in the accompanying figure.

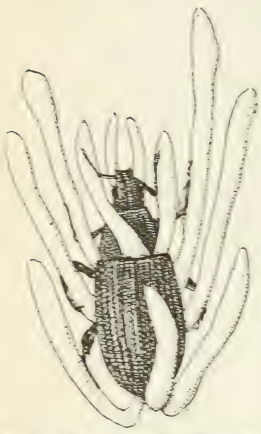

FIG. 7.—*Epiforus imbricatus*; beetle attacked by fungus—three times natural size (original).

This species was rare the past season in the neighborhood of the District of Columbia as compared with previous years. Two complaints, however, reached this office from sources farther south. April 14, we received specimens of the beetles from Mr. David Hunter, San Antonio, Bexar County, Tex., with the information that the species was doing damage to peach, plum, and pear trees by feeding upon the buds and young foliage. The beetles had been troublesome the previous year and were jarred from the trees, but they again put in an appearance the following year in still greater numbers. May 15 Mr. T. G. Knoop, Glenwood, Okla., sent this species with others concerned in injury to apple trees.

A NEW TINGITID ON BEAN.

(*Gargaphia angulata* Heid.)

June 13, 1899, Prof. F. S. Earle, Auburn, Ala., sent specimens of this insect in different stages found on the leaves of bean at that place. Our correspondent had not noticed the insect before, but expressed the belief that it might be quite destructive.

The species was referred to Mr. Otto Heidemann of this division for identification, with the result that it was discovered to be a new species of Gargaphia, to which he has applied the name *angulata* from having found a specimen in the National Museum collection, labeled, in Pro-

fessor Uhler's handwriting, "*Tingis angulata* Uhler MS. on beans, Riley." The locality where Professor Riley made this observation is probably St. Louis, Mo., as most of the unlabeled material from the Riley collection was obtained in the early seventies in the vicinity of that city. As the facts concerning this species are meager, it was thought best to describe the species in a periodical publication rather than in our general series; hence Mr. Heidemann's description was sent to the Canadian Entomologist, and appeared in the issue of October, 1899 (Vol. XXXI, p. 301). The species may readily be determined by this description and by comparison with the illustration which is presented herewith.

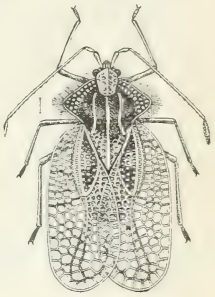

FIG. 8.—*Gargaphia angulata*, much enlarged (original).

It is, as stated by Mr. Heidemann, closely allied to *G. viridescens* Champ., from Mexico and Texas, but differs by the angulated sides of the pronotum, by the larger number of areoles at the costal area, and the longer hairs at the edge of the pronotal margins and of the hood. It is also allied to *G. nigrinervis* Stal., from Colombia and Mexico, but does not have the discoidal area of the hemelytra abruptly closed behind by a transverse, oblique raised nervure.

THE DESTRUCTIVE GREEN PEA LOUSE.

(*Nectarophora destructor* Johns.)

Most remarkable of all the injurious occurrences of insects on edible leguminous crops during the year 1899 was that of the green pea louse, *Nectarophora destructor* Johns., which has overrun and laid waste fields of peas from Nova Scotia and Canada to Virginia and Maryland. It was first reported simultaneously from Virginia and Maryland, and has already been the subject of communications by Professor Johnson, published in Bulletin No. 20 of this Division (new series, pp. 94–99) and elsewhere. The notes which follow may be considered as supplementary to Professor Johnson's articles; the object of the present paper being to record the facts concerning injuries observed and reported to this Division.

INJURIOUS OCCURRENCES OF THE YEAR 1899.

Injury was first reported to this office May 17, when we received from Mr. Thomas Bridges, Bridges, Gloucester County, Va., specimens of the insect, with the report that it was destroying the pea crop in that county. About 1,000 acres of peas were stated to be planted there, and many farmers had already begun to plow them under. The same day Mr. John T. Griffin, Portsmouth, Va., wrote us concerning

the same species, with the report that it was very destructive to the pea crop in that section. May 23 we again received specimens from Mr. Bridges, with the accompanying statement that the species had destroyed the pea crop of that vicinity for shipping purposes, and was then destroying the Canada field peas sowed for hay. The same day a communication was received from Professor Johnson in regard to this insect, which, as this has already been treated in detail in Bulletin No. 20, need not be repeated here. A few days later, Mr. E. D. Sanderson called the writer's attention to this plant-louse and its injuries at College Park, Md., when upon examination of our experimental plats of peas growing on the Department grounds the writer found the same species at work there.

June 2, Prof. G. Harold Powell, Newark, Del., sent specimens, with report that this plant-louse was very abundant on the pea crop throughout the State.

July 3 we received specimens from Mr. D. W. Watrous, East Hampton, Conn., with the statement that "Champion of England" peas were being injured by this insect, the plants being covered with their numbers.

July 7 we received, through Dr. E. P. Felt, Albany, N. Y., specimens from C. J. Allen, Floral Park, Long Island, with the report that one farmer in that vicinity had lost 14 acres and another 20 acres of peas through the ravages of this pest.

July 28, the late Prof. F. L. Harvey, Orono, Me., transmitted specimens, with the accompanying information that this pea louse had been doing a great deal of damage to peas in Maine, several complaints having reached the experiment station. The insect was also abundant in gardens about Orono.

August 9, Dr. James Fletcher, Ottawa, Canada, sent specimens received from New Minas, Nappan, and Truro, Nova Scotia, and from Freeman, Ontario. Dr. Fletcher's correspondent from the last locality wrote, "this is only a fair sample from a 14-acre field; it looks as though the whole crop would be lost." August 22, Dr. Fletcher wrote that this plant-louse attacked not only field peas but tares, and that on the experimental farm at Ottawa it had ruined two long hedges of sweet peas.

August 12 we received specimens from Mr. A. Brakeley, Bordentown, N. J., with the report that his first crop of peas had suffered considerable injury, perhaps one-third being lost; the second crop about two-thirds, while the third crop of 34 acres yielded only a few hundred cans.

From October 30 to November 4 we received specimens in different lots from Mr. Samuel R. Haynes, Portsmouth, Va., from which locality we have previously reported it as very destructive.

Writing December 20, 1899, Mr. C. H. Pearson, of Baltimore, pro-

prietor of the Susquehanna farm in St. Marys County, Md., stated that during that year he had 600 acres of peas and the crop was badly infested by this pea louse, which destroyed 80 per cent of his crop. This loss was a very serious matter, as our correspondent raised no other crops except peaches.

A large proportion of the identifications of the material received were made by Mr. Theodore Pergande, who has also kindly criticised the accompanying illustration of this plant-louse.

THE SPECIES DESCRIBED.

The species was described by Professor Johnson in the February number of the Canadian Entomologist of the current year (Vol. XXXII, pp. 56–60) under the name *Nectarophora destructor*. Attention is called in that article to the preoccupation of the genus Siphonophora both in the Myriapoda and Hydrozoa, for which reason Nectarophora of Oestlund is substituted.

This plant-louse is one of unusual size among those found infesting garden plants, the average length of the body being about 4.5 mm., and the total wing expanse about 11 mm. The general color of both the winged and apterous forms is uniform pea-green, the same color as the insect's favorite food plant. The eyes are prominent and reddish brown in color. The antennæ are lighter than the body and tubercles prominent; joints darker than rest of segments; seventh joint quite filiform and fuscous. The legs are long and conspicuous; tarsi, distal ends of tibiæ, and femora fuscous. The nectaries are fuscous at the apices, otherwise concolorous with the body.

A typical winged female of this insect is shown in figure 9 with wings expanded, showing venation at *a*, and a lateral view of the same with wings folded in their natural position when the insect is at rest or feeding is presented at *b*. At *c* an apterous or winged insect is shown, and *d* shows the nymph in its last stage. The structure of the third antennal joint of the winged form may be seen at *e*, highly magnified.

THE QUESTION OF ALTERNATE FOOD PLANTS.

An effort was made by Mr. Pergande to ascertain if any common species of weeds that were found growing late in October and early in November could be alternate food plants of this insect, but with negative results. The plants upon which the insects were placed, but which they deserted, were *Sonchus asper*, dandelion, shepherd's purse, *Sisymbrium officinale*, and dock.

Throughout the months of November and December, 1899, this or a related plant-louse was observed and is still to be seen on the Department of Agriculture grounds, feeding upon different species of vetches (*Vicia villosa*, *gigantea*, *ludoviciana*, *et al.*) on the experimental plats of

the Division of Agrostology. Large colonies were at work on pleasant sunny days in January, 1900. Many winged individuals occurred at this time and living specimens were in fact to be found all winter, having been last seen March 24 or up to the time of going to press. Unfortunately, winged individuals were not preserved, and a specific determination can not at present be made.

NATURAL ENEMIES.

In spite of the numbers of insects of parasitic and predaceous habits observed by Mr. Johnson and noticed in his article, it was patent to all

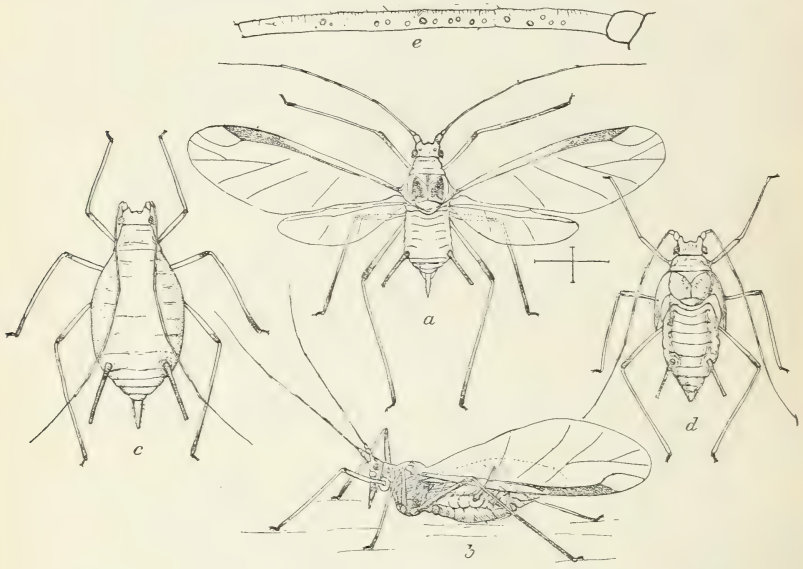

FIG. 9.—*Nectarophora destructor: a*, winged female; *b*, same from side with wings folded in natural position when feeding; *c*, apterous female; *d*, nymph in last stage; *e*, third joint of antenna of winged form—*a-d*, much enlarged, *e*, more highly magnified (original).

who had the species under observation that few of these had any very perceptible effect upon lessening the immense numbers of their host last year.

From Dr. Fletcher we received October 17 some parasites of this species which were identified by Mr. Ashmead as *Praon cerasaphis* Fitch, *Aphidius fletcheri* Ashm. MS., and *Isocratus vulgaris* Walk.

A list of Syrphus fly, ladybird beetle, and other natural enemies of this species has already been furnished by Professor Johnson in his article previously referred to and need not receive further attention here. From the abundance of some of these natural enemies Professor Johnson has expressed the opinion that the insect will not again be so injurious in many years as was the case the past season. In the vicinity of the District of Columbia none of the natural enemies were at all

active during the crop growing season, and there is nothing to indicate that we will not again be visited by this plant-louse here, especially since this or an allied species of plant-louse, as previously observed, was active in the field during the winter months.

It is worthy of remark that Professor Johnson kept the insect feeding upon clover. Though we have been unable to find specimens on clover in this vicinity, only one variety of common white clover growing in the garden patch where the insect was noticed, possibly they may show greater preference for another variety of clover or other perennial plant. Should no such plant be available in other districts, it might be the cause of the insect's dying out to a very considerable extent.

REMEDIES.

Nothing new in the line of remedies has developed during the season. Our correspondents have been advised to use kerosene emulsion, the standard remedy for plant-lice, and it has been suggested that some benefit might follow the rotation of crops. It is a matter of considerable importance that the preferred alternative host plant or plants, if such exist, be discovered, so that the insect may also be killed upon them after their departure from the old pea vines, and that their cultivation may be avoided in the vicinity of peas and other crop plants subject to injury by this insect.

A NOTE ON THE MEXICAN BEAN WEEVIL.

(*Spermophagus pectoralis* Sharp.)

November 15, 1899, we received from Mr. Jared G. Smith, of the Division of Botany of this Department, specimens of a large bean, evidently native to the place from which it was received—Lima, Peru—and infested by the exotic Bruchid, to which the writer has applied the name of Mexican bean weevil, and which has previously received mention in recent publications of this Division as *Spermophagus pectoralis* Shp.

This adds a new locality to the list given by the writer in volume VII of Insect Life (p. 328).

Careful comparison of the large series of this species now in the National Museum collection with the description furnished by Schoenherr of *Spermophagus semifasciatus* points strongly to their identity.

In the year 1858 M. H. Lucas presented before the Entomological Society of France a few remarks on the habits of *S. semifasciatus*, describing the male, which was not noticed by Schoenherr, and evidently also not known to Sharp in his treatment of *pectoralis*. As this communication is brief and of considerable interest, a translation is given herewith:

I will communicate to the society several individuals of both sexes of a Curculionid belonging to the genus Spermophagus which destroys haricots, coming from La Plata, and which I owe to the extreme kindness of our colleague, M. Allard. On studying the legumes attacked by these insects it is remarked that a single haricot often nourishes seven and even eight individuals of the Spermophagus. The larva feeds on the germinative part of the bean, makes in it larger and smaller galleries, and transforms finally into nymph. When the haricots containing these Spermophagus are examined nothing on the exterior reveals the presence of the Curculionids; the nymph changes into the perfect insect, and the latter, in order to issue from the cell in which it has undergone its various transformations, cuts the pericarp of the bean, making with its mandibles a piece more or less circular, which falls, and the perfect insect issues very actively from its cell to go in search of the female. It is to be remarked that often the same bean serves as the cradle of several individuals of both sexes. The learned Schoenherr is the first who has made known this species, to which he has given the name *Spermophagus semifasciatus*, Genera et Spec. Curcul. tom. I, partie I[er], p. iii, No. 12; but he knew only the female and did not add to his careful description the life habits of this pretty little species.

The male is smaller than the female, for it is only about 1.75 to 2 mm. in length. It is entirely gray, more or less variable ("chatoyant"), tending a little to reddish, and the elytra are traversed by striæ, showing a punctuation fine and not very close; the legs and all the body beneath are of a clear ashy gray. The antennæ are gray with their first joints reddish. (Annales de la Soc. Entom. de France, 1858, bul., p. xxviii.)

When it is added that this bean weevil evidently lives for successive generations on stored beans and cowpeas in the same manner as *Bruchus obtectus*, the common bean weevil, and that it is known to inhabit Guatemala, Nicaragua, and Panama, besides Mexico, Peru, and Brazil, we sum up about all that is known concerning it.

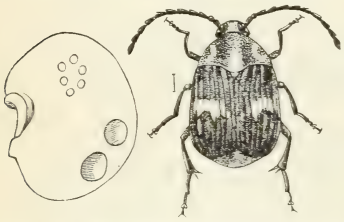

FIG. 10.—*Spermophagus pectoralis:* weevil at right, much enlarged; Mexican bean at left, showing: below, holes made by beetle in egress, above, a group of eggs on surface, three times natural size (author's illustration).

For the further identification of the species, the illustration of the female and of an infested seed, with eggs and exit holes, is reproduced:

The eggs are deposited in great numbers on the beans recently received, from 50 to 100 on each. The eggs, when dry, are light gray in color, nearly circular in outline, about half a millimeter in diameter, and less than half that in depth.

It seems quite likely that this insect has already obtained a foothold in our new possessions, where it will in time become quite as destructive as in the other countries where known to be established, and it is almost equally probable that it will spread, with the increase of our commerce with those countries, to the Southern States.

It has confidently been hoped that an opportunity would offer for the further study of the Mexican bean weevil, but since the taking by the writer of living material at Chicago, during the Exposition held there in 1893, no live individuals have been obtained.

THE CABBAGE CURCULIO.

(*Ceutorhynchus rapæ* Gyll.)

RECENT OCCURRENCE AND INJURY.

During June of 1897 Mr. B. R. Bones wrote to this Department concerning damage to cabbage in the vicinity of Racine, Wis., and later, June 20, sent specimens of the larvæ of the insect concerned in the injury, which proved to be of a species of Ceutorhynchus and the one that has been known in American entomological literature until very recently as *C. rapæ* Gyll.

Incidentally it might be remarked that our correspondent wrote that the loss in his neighborhood during the fall of that year was over 2,000 tons of cabbage rotted in the field and in storehouses, this loss being due probably to cabbage rot, which he believes is disseminated by this insect.

August, 9, 1898, Mr. Henry J. Gerling, St. Charles, Mo., wrote of injury to the stems of kale, which is with little doubt due to this same species. He was, however, unable to find specimens. The plant begins to rot just below the leaves, and this follows the stem down to the ground. There appears a small opening in the top part of the stem, which grows from 2 to 8 feet high, and it is hollowed out sometimes far into the ground.

During the first week of May, 1899, the beetles of this species were observed in considerable numbers on the hedge mustard, *Sisymbrium officinale*, an introduced European weed that grows almost everywhere in meadows and in waste places in this country, and which is particularly abundant in the vicinity of the Department of Agriculture. The beetles were all observed singly at this time, preferably on plants of advanced age that were already in flower, and were usually hiding beneath or near the buds and flowers. Later the species was observed on turnip and horse-radish at Tennallytown, D. C., as will be related in detail in the account of the life history and habits of the species.

June 26, 1899, Mr. Bones sent, by request, another lot of young cabbage plants showing injury by what is now proved beyond doubt to be this species, by finding the larvæ in some of the affected stalks. The plants were between 3 and 4 inches in height, and in many cases the larger leaves were wilted. The stalks showed the punctures made by the female in the deposition of her eggs, and in some cases a hole had appeared just below the base of the leafstalk, through which the larva, which was found within, was forcing its soft, brown castings. Larvæ were nearly mature at this time, and some few had evidently already left the plants. The burrows are quite short where only a single larva is present in the stalk, measuring only about 7 or 8 mm.

in length. In figure 11, *a*, a stalk is opened, showing a larval burrow. At the point where the castings are forced out, which may be the same place where the egg was first deposited, the plant fibers become so stretched that the scar gives to the plant the appearance of being partially split open at this point. Such a stalk is shown in the figure at *b*. Our correspondent writes that the work of the curculio was more apparent in early seed beds. In 1898 the insects were very scarce, and he stated that his plants did not suffer from the rot. He con-

FIG. 11.—Work of *Ceutorhynchus rapæ* in young cabbage: *a*, stalk opened to show larval burrow; *b*, scar left after escape of larva from stalk—natural size (original).

siders this curculio to be the main source of inoculation of the cabbage rot, the beetles going from sick to well plants in the seed beds.

EARLY OBSERVATIONS; REMARKS.

In the collection of the National Museum are series of specimens labeled: "From Allis, Adrian, Mich., seed cabbage, April;" "St. Louis, Mo., horseradish, April 20" (identified by LeConte as *C. rapæ*, January, 1876); "From A. J. Cook, Lansing, Mich., on cabbage."

This curculio is well known as an injurious enemy to cabbage and other cruciferous crops and has received mention as such in the Annual Report of this Department for 1889 by Miss M. E. Murtfeldt (pp. 136, 137), as well as elsewhere, but has not hitherto been figured in Departmental publications, and considerable has been learned by the writer that has not previously been recorded.

The prediction made by Miss Murtfeldt, who stated ten years ago that this insect gave promise of becoming a general and very considerable pest to our market gardeners, has hardly been realized to date, notwithstanding its present very general establishment throughout the Upper Austral area, as well as adjacent regions in the United States and Canada, and in spite of evidence that the species has been established in this country at least since 1873, as will presently be shown.

THE SPECIES IDENTIFIED.

Attention must be called to the unfortunate determination of the species in different publications, and an endeavor will be made to straighten out this difficulty.

According to Dr. William G. Dietz, the cabbage curculio of this country is not the true *rapæ* of Gyllenhal, but a native American species and undescribed until 1896, when he gave it the name of *C. affluentus* in his revision of the Ceutorhynchini inhabiting North America (Trans. Amer. Entom. Soc., Vol. XXIII, p. 421). He says: "This species, erroneously known in our lists and collections as *rapæ* Gyll., bears only a superficial resemblance to its European congener while differing in most important structural characters." He then specifies the points of difference, emphasizing more especially the unarmed femora and claws of *C. rapæ*. In the course of the arrangement of the Ceutorhynchini of the national collection, Mr. Schwarz gave this matter some study and has satified himself, as has also the writer, that Dr. Dietz's conclusions were erroneous. In Gyllenhal's original description of *C. rapæ*, published in 1837 (Schoenherr's Gen. et Spec. Curculionidum, Vol. IV, p. 547), there occurs the following: "*femoribus parum crassis, subtus dente mediocri armatis*," and in Thomson's description of the same species, published in 1865 (Skandinaviens Coleoptera, Vol. VII, p. 271), that writer says "*Femora denticulo armata. Unguiculi tarsorum bifidi.*" In Bedel's synopsis of species of Ceutorhynchus (Faune des Coléoptères du bassin de la Seine, 1885, Vol. VI, pp. 163–171) the toothed nature of the femora and the claws of *C. rapæ* are also referred to.

Among the European material which we have had for the study of the genus Ceutorhynchus is a specimen identified by a European authority as *rapæ*, which is manifestly an incorrect determination, since the femora are mutic and the claws simple. It is possible that

Dr. Dietz obtained his specimens of the alleged "*rapæ*" from the same source, and hence the unfortunate error.

For this reason it seems to be advisable to consider our cabbage curculio as being identical with the European *C. rapæ* as long as the contrary is not proven by comparison with correctly determined specimens.

It should be added that *C. napi* Gyll. is entirely distinct and scarcely to be confused with *rapæ*, except by the most superficial study. The habits of both species of feeding upon Cruciferæ were known to their describers, as evidenced by their specific names.

European systematists have lately adopted as the spelling of this genus, Ceuthorrhynchus; but as the original characterization by Germar gives Ceutorhynchus (Insectorum Species, Vol. I, p. 217), and no valid reason is known to the writer for the change, the latter spelling is retained.

INTRODUCTION IN AMERICA.

It appears probable that the cabbage curculio was introduced into this country and had established itself at a comparatively early period, and that the point of its original introduction was in New England and not far from the coast line. As early as the winter of 1873–74 Messrs. Hubbard and Schwarz obtained specimens at Lynn, Mass., and at that time, Mr. Schwarz assures me, he saw specimens in the collection of Mr. E. P. Austin, which had been collected in the same district and prior to that date. No record appears to have been made of the dates of earliest capture. Possibly, however, the species referred to by Dr. A. S. Packard in an account which he gave many years ago of what he called the "radish-seed weevil," and which was identified as *Ceutorhynchus assimilis* Payk., in his second report of the insects of Massachusetts (Rept. Mass. Board Agr. for 1871 [1872], pp. 341, 342; 9th Rept. U. S. Geol. and Geogr. Surv. for 1875, pp. 763, 764), may have been this insect. This is the more probable, as one of the illustrations (made from an American specimen) fits *rapæ*, as does also the description. The singular identification of this insect, whatever it may have been, was obviously made by comparison of specimens, with the description and illustrations furnished by Curtis in his "Farm Insects" (pp. 104–106). The insect was stated to have been found in Maine in 1857 upon radish leaves, and it would seem unnecessary to state that the identification was incorrect, since the true *C. assimilis* is European and not as yet known to occur in America.

DESCRIPTION OF THE SPECIES.

The mature weevil measures about an eighth of an inch and is of broadly oval form, being about three-fourths as wide as long.

The body is somewhat depressed above, the thorax is prominently longitudinally sulcate or channeled at the middle, and is gradually narrowed toward the head, near which it is constricted. The head terminates in a rostrum or snout, which is longer than the thorax. Near the middle of the rostrum are inserted the elbowed and clubbed seven-jointed antennæ. The femora or thighs bear each a tooth on the ventral surface, and the claws are armed with a long, nearly bifid tooth.

The entire body of hibernated specimens is uniformly clothed with a light-gray vestiture consisting of piliform scales, while newly bred individuals, as was learned by the investigations of the season, are coated with ochreous scales. The real color below the scaly covering is black, and the older individuals appear leaden-gray in color and the fresher ones fulvous. Such a difference in coloration imparts to the insect quite a distinct appearance, so obvious that Dr. Dietz has separated the fulvous form as a variety. The elytra are longitudinally striate, as shown in the illustration (fig. 12, *a*). A side view of the insect, showing rostrum and antennæ, is furnished at *b*.

Full measurements give the length, exclusive of rostrum, at 2.7 to 3.25 mm.; width, 1.6 to 2 mm.

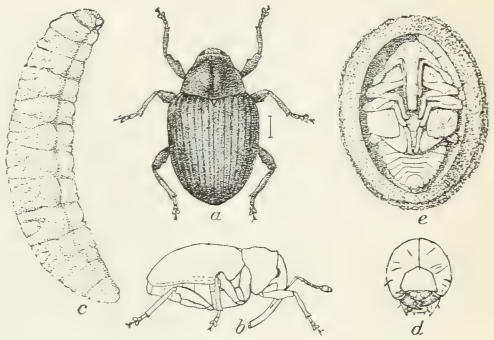

FIG. 12.—*Ceutorhynchus rapæ: a*, beetle; *b*, same in profile; *c*, larva; *d*, head of same; *e*, pupa in cocoon; *a*, *b*, *c*, *e*, eight times natural size; *d*, more enlarged (original).

DISTRIBUTION.

The cabbage curculio is evidently abundant in its native home, its range extending through northern and middle Europe.

The habitat accorded by LeConte and Horn is: "Canada, Eastern and Western States." The exact localities from which specimens have been taken, as exemplified in local collections and as shown by available records, include: Lynn, Mass.; Ithaca (July 5–24) and New York, N. Y.; West Hoboken, N. J. (Juelich); southwestern Pennsylvania (Hamilton); Marshall Hall, Md.; Washington, Tenallytown, D. C.; Rosslyn, Va. (May 5–June 14); Dayton, Port Clinton, Xenia, Waterville, and Wooster, Ohio; Glasgow, St. Charles, and St. Louis, Mo.; Illinois (Hamilton), southern Illinois; Adrian and Lansing, Mich.; Racine, Wis.; Kansas (Snow); Coolidge, N. Mex. (Wickham); Canyon City, Colo.; Argus Mountains (April) and Los Angeles, Cal. The following States are also represented without definite localities: Maryland, Iowa, Kansas, and Nebraska.

The species is evidently most common in the Upper Austral life zone, although it extends into what is considered Transition. The fact that it ranges throughout the Upper Austral zone from ocean to ocean is another link in the chain of evidence of its being an introduced species.

DESCRIPTIONS OF THE EARLIER STAGES.

The egg.—The egg is of rather large size as compared to the beetle, and extremely irregular in outline. Of ten eggs examined, two were broadly oval and two were subpyriform, the remainder being elliptical oval. The color is clear, nearly transparent gray, and there is no visible sculpture, the surface being highly polished. The consistency is fairly firm. The length varies from 0.65 to 0.85 mm. and the width from 0.35 to 0.45 mm.

The larva.—The larva is elongate cylindrical, when full grown measuring about four times its greatest diameter. In color it is milk white, with pale brown head. Its body is much less curved than is usual in the Rhynchophora, the curvature when in natural resting position being about as shown in the illustration (fig. 12, *c*). It tapers abruptly and about equally at each end, the small head being of about the same width as the anal segment. Segmentation is quite pronounced at the sides as viewed from above, moderately on the venter as viewed from the side and feebly on the dorsum. The surface is feebly wrinkled as compared with many rhynchophorous larvæ. The transverse lines and ridges of the dorsal and lateral surfaces are fine and straight. Alternating with these there are transverse rows of minute rounded tubercles, some of them piliferous, the hairs arising from them being extremely fine and short, so fine, indeed, as not to be visible under an ordinary hand lens. The head (*d*) is nearly circular in outline, pale yellow in color, with brown mandibles. The V-space and temporal suture are rather faintly defined. The mandibles are bidentate and the surface carries a few fine short hairs like those on the body. This larva has no appearance of leg pads as are to be found in many Rhynchophora.

The length, curved as in the illustration, is about 5 mm., and when extended 6 mm., the width being about 1.3 to 1.4 mm.

The pupa.—The pupa with its snout bent downward between the forelegs on the under surface of the body is at once recognizable as a Curculionid. Its color is pure milk-white, like the larva. The knees head, thorax, and anal segments are tufted with short bristle-like setæ. These are very short and minute, much shorter than in Conotrachelus, and arranged in pairs except on the thorax, where there are many. There does not appear to be any at the sides of the abdominal segments as in Conotrachelus. The length is about 4.5 mm.; the greatest width about half that.

A pupa is shown in its cocoon at *e* of figure 12.

Pupation takes place in a rather regular and compact oval cocoon, formed of particles of earth joined together, presumably by an adhesive substance, perhaps including a small admixture of silk. The cocoons are but slightly larger than the pupæ, measuring about 5 mm., and being about 3 mm. in diameter. They are formed a very slight distance, less than half an inch, below the surface of the earth, in the immediate vicinity of the infested plants. The pupæ rest within the cocoons, and these in turn lie in small earthern cells, from which they can readily be dislodged intact. They are sufficiently hard and firm to retain their shape after the issuance of the beetles.

BIOLOGIC LITERATURE OF THE SPECIES.

On the Eastern Continent *Ceutorhynchus rapæ* has apparently not attracted any attention as an injurious species, and the writer is unable to find in any of the more popular European publications any mention of its attacking useful plants.

Of its habits, Redtenbacher (Fauna Austriaca, Die Kafer, Vol. II, 1874, p. 347) says that the species "lives on *Cochlearia draba*, and in the larval condition in the roots of this plant. The mature larva goes into the earth and forms for pupation a small cocoon from the earth."

If there were any way of proving the identity of the species mentioned by Packard (l. c.) American biologic literature would begin with the publication of the note in question in 1872.

In the Annual Report of this Department for 1888 (p. 136), as previously noted, Miss Murtfeldt, formerly an agent of this Division, gave our first biologic account of this species under the heading "The cabbage curculio (*Ceutorhynchus napi*)," based upon its injuries to cabbage in hotbeds at Glasgow, Mo. The insect was stated to have injured over half of 40,000 plants, and some facts in its life history are contributed, including mention of its rearing several years before that time from larvæ boring the stalks of wild pepper-grass, *Lepidium virginicum*, as well as original descriptions of the egg, larva, and cocoon.

Injury is described as being shown by the puncturing and fretting of the plants in the crown and along the principal veins, a large proportion of the plants dying from this form of attack. The plants were stated also to be punctured in the center or at the side of the crown, and to contain a small white grub which was boring downward in the root, the soft castings filling the tunnel in its rear and being often forced out through the entering fissure. The year following, the same writer again called attention to injury by this species, mention being made under the name of *Ceutorhynchus rapæ*. Attention was also called to its appearance in the garden of Mr. F. M. Webster, at Lafayette, Ind., in May of that year (Bul. 22, Div. Ent., p. 73).

In 1892 the cabbage curculio was again reported injurious in Missouri by Miss Murtfeldt (Bul. 30, p. 50), when it was the occasion of "much loss and annoyance to market gardeners in some parts of the State by boring into the crown and roots of young cabbage and cauliflower plants, in many cases destroying 25 per cent of the plants in the hot beds and just after they are set out."

It was noticed at this time that the insects did not trouble the plants after the head began to form. From experiments conducted that year this writer became convinced that the insect returns to its original food plant, wild peppergrass, from the stems of which young larvæ were obtained in July.

In 1895 Mr. Webster gave a brief notice of injuries to young cabbage near Dayton, Ohio (Bul. 2, n. s., pp. 90, 91), and later furnished a more complete account (Bul. 77, Ohio Agl. Expt. Sta., pp. 50–52). In the Canadian Entomologist of March, 1896 (Vol. XXVIII, pp. 59–61), under the title "*Ceutorhynchus napi* or *Ceutorhynchus rapæ*," the same writer also published an article on this species, together with illustrations of the beetle, its larva and its work.

RECENT OBSERVATIONS ON THE BIOLOGY OF THIS SPECIES.

Upon opening a stem of hedge mustard, May 5, in the locality infested by the beetles on the Department grounds, no less than a dozen eggs were disclosed in the first inch and a half of the stem just beneath the flowers. They were resting in the pith, where they were inserted through punctures made in the stem by the rostrum of the parent beetle, the scar showing the place of deposit.

That the beetles appear much earlier, and egg deposition is consequently earlier than the first of May, was proved by finding in the same stem and in others toward the base numerous larvæ, some nearly full grown. Injury by this weevil to cabbage at Glasgow, Mo., as reported by Miss Murtfeldt, was noticed the latter part of April.

May 9, 1899, in a search for this species at Tennallytown, D. C., the beetles were found to occur but rarely on turnips, but were more abundant in the same garden in a bed of horse-radish.

At about this time it was noticed that the larvæ, as they approached maturity in hedge mustard, cut holes through the stalks, usually on the lower side of the axil of the branch or leaf-stalk. It was not ascertained just when the larvæ left the stems, but from the size of the openings toward the middle of May it is probable that some had already begun to desert the stems to enter the earth. Stems examined May 20 were found either to have been vacated or the larvæ were just completing their growth or preparing to cut their way out.

From what has been said of the number of eggs deposited in a stem it follows that many larvæ occur in a plant. Judging from some examined, sixty or more larvæ often find lodgment in a single stem and

its branches. Larvæ are found most numerous in the upper portion of stems, penetrating frequently as high as the diameter of the stem will admit them. They also bore into the branches, and occasionally a short distance into the leaf-stalks. In the upper portions the stem is often completely hollowed out toward the base, the larval tunnels growing much smaller.

In many cases the leaf-stalks are killed or so injured that they part from the stems when the latter are pulled up; and, again, the stems, being so closely tunnelled, often part above the middle, even dropping over, though not handled.

By the end of the month no larvæ could be found in any of the stems of hedge mustard examined, and on removing the earth from about the bases of the stems numerous cocoons were obtained. As a rule, weeds seldom suffer from the attacks of injurious insects as do cultivated plants; it is somewhat surprising, therefore, to find that quite a number of plants of hedge mustard had been so completely bored through in the upper parts of the stems that they cracked open, and the plant bent over at the point of fracture, and as a consequence the plants were in some cases injured so that the seed did not fully mature.

June 2 a second visit was paid to the garden at Tennallytown, D. C., and although the beetles had entirely vanished from our Department grounds, numerous specimens were found here upon seed turnip, as also larvæ in the stems of turnip and in the leaf-stalks of horse-radish. Affected plants of both turnip and horse-radish could be readily detected by the scars left by the puncture of the beetle and by the holes made by the larvæ, but it could not be ascertained what effect the presence of the insect had upon these crops, as the plants were plowed up when the place was next visited.

June 10 beetles of the new generation were observed, though rarely, on turnip at Marshall Hall, Md., this rarity being explained, at least in part, by the absence of native food plants in the vicinity.

During the next two weeks beetles were found at work on the leaves of cauliflower and cabbage on our experimental plats, being more commonly met with on the former plant, and nibbling almost exclusively along the edges of the leaves in much the same manner as *Phyllotreta vittata*.

THE NUMBER OF GENERATIONS.

It would scarcely seem necessary to devote any time to the subject of number of generations produced annually, since with scarcely an exception in the temperate climate of the United States the true weevils (Rhynchophora, exclusive of the Scolytidæ) are monogoneutic. Nevertheless the question has been raised. To ascertain the truth, beetles of the new generation were confined in a large rearing cage with healthy

potted turnip and cauliflower. On the leaves of the former they fed freely, but no punctures were made in the stems, and no eggs or larvæ were found in them, neither could they be found in hedge mustard nor cauliflower, upon which the beetles had been seen.

Owing to the difficulty in obtaining natural conditions for the curculios in confinement, the exact periods of the different stages were not observed; but from the facts ascertained we may deduce the life cycle with tolerable exactitude, reasoning from analogy, the ascertained data concerning other species.

SUMMARY OF LIFE HISTORY.

The following summary is based upon observations made in the District of Columbia upon the Department grounds:

The beetles make their first appearance some time in April and begin the depositing of their eggs, selecting by preference for the purpose wild-growing plants, such as hedge mustard. The parent beetle, after copulation with the male, punctures the stem of the host plant while the plant is still young, inserting her eggs in the holes made. It seems probable that oviposition begins some time about the middle of April, and continues at least a month, the parent insects practically all dying and disappearing by the end of May, as only one or two stragglers could be found by sweeping infested patches after that time.

The egg period will vary slightly, as do all the periods, according to the temperature, between five and eight days being the approximate time. The larvæ feed within the stems and larger leaf-stalks, and in about three weeks complete their growth, cut their way out, usually near where the leaf-stalks join the stem and enter the earth. Just beneath the surface of the earth they form little round earthen cocoons, and within these remain for about two weeks longer before forming the pupa. The pupal period is about the same as the egg, five to eight days, when the mature beetle is formed and cuts its way through one end of the cocoon and issues above ground. The first pupa observed was found May 20, and the first imago appeared June 3 in its cocoon. Within ten days later most of the beetles had made their appearance in the infested locality, all at this time being readily recognizable from the hibernating specimens by their darker tawny color. On the Department grounds none of the first or hibernated generation could be found at this time, consequently there was no overlapping of generation. The beetles had all deserted their wild plant by the end of the middle of June, but were still present on cauliflower and cabbage June 21.

A noticeable feature of the observations on the Department grounds was that cabbage, which was set out purposely in the immediate vicinity of the hedge mustard, showed no signs of infestation from the

hibernated generation, a fact which can be utilized in the control of this insect in the field, since if an abundance of the wild and preferred plants be available when the insects first appear it does not seem probable that cabbage would be attacked. In short, cabbage appears to be one of the last plants attacked in the field when any other palatable crucifer is obtainable. The beetles not only greatly preferred hedge mustard and wild pepper grass, but appeared to attack also, by preference, turnip, horse-radish, and cauliflower.

NATURAL ENEMIES.

One would suppose from the habit of the larva of this species of living within the stems of its host plant that it would not be particularly susceptible to parasitic or predaceous enemies, and such is probably the case. The adult insects are so minute and inconspicuous, and drop so readily from their food plants when disturbed, that they are probably not often attacked, and the cocoons are very seldom invaded by predaceous insects. Nevertheless the larvæ are sometimes killed by other insects. After a larva has made a hole in the stem, small as it is, ingress is afforded to natural enemies. In a stem of horse-radish growing in a spot where other larvæ of this species were found at Tennallytown, D. C., the pupa of a Chalcidid parasite was discovered, together with a portion of the head of the larva, leaving no doubt as to parasitism of the species. The adult issued June 5, and proved to be *Omphale livida* Ashm., the same species reared from the lepidopterous borer of Lima beans, mentioned in the discussion of that species. It was originally described from Florida in 1886 (Trans. Am. Ent. Soc., Vol. XIII, p. 135) under the genus Oxyomorpha.

METHODS OF CONTROL.

From what we have learned of the life history of this species it would appear that our principal reliance in its treatment lies in adopting preventive measures rather than in the use of insecticides. It seems quite probable that injury to hothouse plants of the nature which has been recorded may have been due to the introduction of soil in which the beetles were hibernating.

The utilization of wild food plants as a trap crop, etc.—If, as happened on the Department grounds the past year, the insect on its first appearance finds an abundance of its wild and preferred food plant, cabbage or other cruciferous crops of the vicinity are not apt to be affected to any observable extent. In localities where an invasion of this beetle has once occurred, it will be well to kill the insects by pulling up and destroying their wild food plants—not early in the season, but as soon as the adults have deposited their full quota of eggs and before the larvæ have left the stems. The proper time for this measure of

control would be before the middle of May in a climate such as that of the District of Columbia and about the middle of June in the Northern States.

Hot water; bisulphide of carbon.—In case some of the larvæ have escaped before this operation is carried out, they can be killed in their cocoons by drenching the earth about the plants with hot water. The insects can be destroyed in hothouses in the same manner, as advised by Miss Murtfeldt. If the degree of infestation does not justify the use of hot water owing to the danger of killing the growing plants, bisulphide of carbon could be substituted and injected into the ground by means of a McGowen injector, or some similar syringe in use for that purpose, or by simply pouring it about where the cocoons are found.

Arsenical poisoning.—The beetles, as previously stated, consume quite a quantity of the tissue of the plant and feed about the edges of the leaves in the same manner as do the cabbage flea-beetles. Where it is found necessary to protect cabbages against cabbage worms and other leaf-feeding insects, the Paris green or other arsenical used for the purpose will also kill this curculio, and no other remedy should be necessary.

Other measures.—We should, however, avoid taking earth into the greenhouse at a time when it is liable to be infested with these insects, and particular attention should be observed that it be not taken from the vicinity of cruciferous weeds. If the earth be sterilized, the heat would kill the curculios or other insects which it might contain.

It should be unnecessary to add that when the plants are found to be badly infested they should be pulled up when their loss seems assured and burned with their contained larvæ. The application of kainit or other fertilizer about the roots of less infested plants would assist these in recuperating from attack.

REMARKS ON THE FOOD HABITS OF SPECIES OF CEUTORHYNCHUS.

Forty-seven species of the true genus Ceutorhynchus, as at present restricted, inhabit America north of Mexico, but the habits of only a few of them are definitely known. Such of these as have been studied live in their larval state on the Cruciferæ.

EUROPEAN SPECIES OF CEUTORHYNCHUS.

On the Eastern Continent species of this genus inhabit also plants of other orders. In Europe alone 176 species have been recognized (Catalogus Coleopterorum Europæ, 1891). Of these, Bargagli (Rassegna Biologica di Rincofori Europei, pp. 255–267) has recorded biologic observations on 58 species, and in all save in a few cases mentions the food habits.

Among the European species of Ceutorhynchus which are enemies

of cultivated plants of the mustard family *C. sulcicollis* Gyll. and *C. assimilis* Payk., known respectively as the cabbage gall weevil and the turnip weevil, are the most important and receive mention in most economic works published in Europe. They injure alike cabbage, kale, rape, and turnip.

C. roberti Gyll., according to Rupertsberger (Verhdl. zool.-bot. Ges. Wien, 1887, Vol. XX, pp. 837–839), has similar habits to the cabbage gall weevil attacking *Raphanus raphanistrum* and rape.

The above three species, together with *C. cyanipennis* Ill. and *C. quadridens* Panz., which will be shortly mentioned, are included in a consideration of the crucifer-feeding Ceutorhynchus in Taschenberg's Insekten-Kunde (Vol. II, pp. 161–166).

C. contractus Marsh., the charlock-seed weevil, is recorded to do injury to turnip in England (Curtis's Farm Insects, p. 106).

C. napi Gyll., like *C. rapæ*, is not mentioned in any European popular economic works consulted, although both Goureau and Taschenberg have made reference to injury by it to both cabbage and colza or summer rape.

THE SEED-STALK WEEVIL.

The question of the proper nomenclature, or more strictly speaking identity of the cabbage curculio of North America with the European *Ceutorhynchus rapæ* led to some further study of certain other forms, with the result that a species treated by Mr. F. A. Sirrine (Rept. N. Y. Agr. Expt. Sta. for 1895, p. 603), and identified as undescribed by Dr. Dietz, proves with little doubt to be identical with a European species, *C. quadridens* Panz. This species was given the name of *C. seriesetosus* and described on page 422 of the Transactions of the American Entomological Society for 1896.

The occurrence of this insect in America is evidently of very recent date, the specimens received by Mr. A. Bolter from Nantucket, Mass., appearing to be the first collected, and at the present writing there is no further knowledge of the insect's distribution than that it occurs in the locality mentioned and on Long Island in the vicinity of Cutchogue. It appears to have been first noticed on Long Island in 1895.

The exclusive occurrence of this species only on our Atlantic coast, close to our great shipping ports, as well as the fact that thus far it is known to attack only cultivated plants, although searched for on others, led to the suspicion by Mr. Schwarz and the writer that it might be a foreign importation and of recent introduction. Mr. Sirrine has kindly sent a series of specimens of *C. seriesetosus* for examination, and Mr. Schwarz has now ascertained from comparisons with descriptions and European specimens that the species is doubtless identical with the European *C. quadridens* Panz., a common and widely distributed insect in its Old World home.

Ceutorhynchus quadridens was given its specific name by Panzer in 1796 (Faunæ Germanicæ, Heft. 36, p. 13).[1]

The first biologic account appears to be that given by Colonel Goureau in 1866 (Annales de la Société Entomologique de France, Vol. VI, p. 171). This is in connection with its development from larvæ living and feeding within the roots of "navette," or rape (*Brassica napus*).

Redtenbacher (Fauna Austriaca, Vol. II, p. 344) has mentioned its occurrence on the same plant in Austria, and Bargagli (l. c., p. 264) states that the beetles are found at Florence in April on the flowers of *Cochlearia armoracia* (horse-radish), also upon cavolo (cabbage). To this list Perris (Larves de Coléoptères, 1877, p. 408) adds as food plants mustard (*Sinapis nigra*) and watercress (*Nasturtium officinale*).

Writing November 17, 1899, Mr. Sirrine said that he could easily see how this pest might have been imported with the seed of cabbage, kale, or turnips, as the adults issue on Long Island, in the neighborhood of Jamaica, before the seed is gathered. The reason why the species has not been observed in other sections of the island, however, where the seed-growing industry is not followed, is not so clear, but our correspondent assumes that the beetles can not obtain a foothold in sections where the above plants are grown merely for marketing, in spite of the fact that in most neglected fields wild radishes and various wild mustards and other cruciferous plants grow which ought to furnish suitable food for the beetles in all portions of the island.

This species will be seen to differ at once from the cabbage curculio by its smaller size, being about a tenth of an inch in length; by its subtrapezoidal form, and by the colors of its scales. These are white and intermixed with gray hairs, the whole forming a somewhat indistinct pattern, whereas *rapæ*, it will be remembered, is uniformly gray or fulvous. The scutellar spot is prominent and the elytra are marked by strong rows of erect setæ.

CEUTORHYNCHUS CYANIPENNIS GERM.

What appears to be the first record of the occurrence of this species in America is by the late William Juelich, in volume V of Entomologica Americana (March, 1899, p. 57), in a note in which he refers to a series of specimens taken by the writer at Ithaca, N. Y., and to others found by Dr. Otto Lugger at Baltimore, Md. The writer first observed this species about 1879, but there were at that time in the collection of the Cornell University a series of this weevil taken in the same region in the early seventies, and as near as can be remembered in 1873.

[1] It was afterwards redescribed under the same name by Gyllenhal (Schoenherr's Genera et Species Curculionidum, Vol. IV, p. 534), and later by different authors under the names *boraginis* Gyll., *calcar* Panz., *pallidactylus* Marsh, and *quercicola* Marsh.

Mr. H. F. Wickham has recorded this species from Idaho, Dr. Hamilton (Trans. Amer. Entom. Soc., Vol. XXI, p. 405) records it from Illinois, and Dr. Dietz (l. c., p. 31) states that it occurs also in California.

C. cyanipennis can be readily distinguished from any other Ceutorhynchus occurring in this country, except *C. bolteri* Dietz, by its color alone. Its elytra are steel blue, hence the specific name. It is larger than *bolteri*, and has toothed claws.

In Bargagli's reference to this species (l. c., p. 259) he gives *sulcicollis* Gyll. as a synonym, but *C. sulcicollis* Payk. is distinct. He refers to its occurrence on *Sinapis arvensis*, *Capsella* (*Bursa*) *bursa-pastoris*, *Achillea millefolium*, cabbage, rape, and horse-radish, giving references in full for food plants, as well as for notes on the larva and its habits.

Although this species has been established in America for a great many years, it has yet to be found attacking useful plants; in fact, to the best of the writer's knowledge, no food plant has been observed in this country.

FOOD HABITS OF NATIVE SPECIES OF CEUTORHYNCHUS.

Ceutorhynchus septentrionis Gyll.—At the same time that the cabbage curculio was observed on the Department grounds on *Sisymbrium officinale* during the first week of May, 1899, the beetles of this species were found, but not in the same abundance, in a truck garden at Tennallytown, D. C. They occurred in much greater abundance than the cabbage curculio, being particularly numerous in a large bed of horse-radish and comparatively rare on cultivated mustard. May 13 beetles were found by the score on single plants of yellow rocket (*Barbarea barbarea*) at Rosslyn, Va., occurring on every plant examined.

C. adjunctus Dietz, from Utah and Nevada, has been collected by Mr. Schwarz, on a species of Stanleya.

C. hamiltoni Dietz has been found in Massachusetts on the maritime plant sea rocket (*Cakile americana*).

ADDITIONAL NOTES ON THE IMPORTED CABBAGE WEBWORM.

(*Hellula undalis* Fab.)

Since the article on the imported cabbage webworm, *Hellula undalis* Fab., was published (Bul. 19, n. s., pp. 51–57) a number of facts have been ascertained that are new and that bear upon the biology, distribution, and probable origin of this species. An additional economic article on this insect, by Mr. W. M. Scott (Bul. No. 1, Georgia State Board of Entomology, April, 1899, pp. 17–25), has appeared, and the writer has obtained access to three recently published works treating of this species which were not before available. The insect has been carried through its several stages, and this, with the descriptions of the

egg and first larval stage, will practically complete the account of the life stages as well as can be accomplished by office experiment alone.

From latest information it appears that injury by this webworm was first detected in the United States in 1895, and from what is known of introduced insects in general it may be conjectured that it was introduced at a considerably earlier period, probably several years prior to the date mentioned, as it often requires a number of years for a species of insect to become established after its arrival in a new country.

The receipt of specimens from other sources and the reports of injuries in new localities go to show a much wider distribution for the insect than credited hitherto. Its occurrence, as now ascertained, in South Carolina and Alabama renders it more than probable that it already ranges throughout the Gulf region, although as yet perhaps not in troublesome abundance, except in the States mentioned and in Georgia.

In the other works to which reference is made, and which will later on be cited, considerable is added to our knowledge of the insect's foreign distribution; in short, it is shown that the species is already cosmopolitan and evidently rapidly widening its range.

ADDITIONAL LITERATURE OF THE SPECIES.

As a result of our first article, we received a communication from Mr. Arthur M. Lea, Government entomologist, Department of Agriculture, Hobart, Tasmania, who wrote under date of June 27, 1899, that this species occurs in very destructive numbers in western Australia. While entomologist to the agricultural department of that colony he published several notes on the species, which he describes as being the worst of all cabbage pests. The species was unfortunately referred to as *Evergestis rimosalis*, but subsequently specimens were identified by Mr. Otto Lower, an Australian microlepidopterist, as *Hellula undalis*. One of these notes is published in the Journal of the Bureau of Agriculture, volume IV, page 1420, issued at Perth, West Australia, December 1, 1897.

In the article referred to, which is the only one of Mr. Lea's that is accessible at the present writing, the insect is called the "stinking-head moth." Two characteristic appearances are described as being due to the work of the larva, called, respectively, "stinking-head" and "balloon head," the latter being figured. "In damp, rich soil the heart becomes a blackish crust, beneath which is a slimy, stinking fluid swarming with maggots and various insects. In drier soil the outer leaves drop off, the head dries and becomes balloon-shaped, and the larval excrement may be seen on the stem and crown; the latter may be knocked off at a touch; whole rows can be seen that have been so destroyed."

The remaining publications will be mentioned later on under the head of notes on distribution.

The various accounts of the method of attack, and particularly of the feeding of the larvæ reported by correspondents and recorded by others, do not agree in every detail.

EARLY APPEARANCE OF THE INSECT IN SOUTH CAROLINA.

Through an unfortunate oversight an earlier rearing of this pernicious webworm was overlooked and hence not recorded.

August 10, 1896, we received from Mr. H. M. Simons, Hayfield Farm, Charleston, S. C., larvæ and pupæ, with the statement conveyed in a letter of August 6 that the species was very destructive to young cabbage in that vicinity. Our correspondent had planted cabbages for many years and had first noticed this insect in 1895, when only a few were seen. At the time of writing it was estimated that $100 worth of plants had been lost on account of the webworm. Many of our correspondent's neighbors had lost all their cabbage plants, and this in spite of tobacco water and Paris green, the latter applied both dry and in liquid form. The moth was stated to lay its eggs on the upper side of a leaf, and the young larva upon hatching entered the leaf and ate between the inner and outer sheaths, working gradually downward.

Mr. N. L. Willet, Augusta, Ga., who furnished information concerning this species and its occurrence in his vicinity in 1898, again sent specimens the present season with accompanying letter of August 29, and the information that it was only then being noticed by its ravages in that county. Not very much harm had been done at that time, and our correspondent was of the opinion that the insect was later in its appearance than in the previous year. In short, it was difficult at that time to find larvæ, the truckers of the vicinity declaring that they could not obtain the "worms" at all.

September 12 we received another sending from Mr. Simons, with the statement that the insect had done a great deal of damage to young turnip plants. It was noticed that the larva in our rearing cages fed on the common shepherd's purse, *Bursa* (*Capsella*) *bursa-pastoris*. In the letter accompanying this last sending our correspondent stated that in all his years of farming he had never seen such complete and utter destruction of any crop as by this little insect. He wrote that it attacked plants in all stages of growth; turnips just after they were clear of the ground. He had lost his entire planting of cabbage, the seed alone of which was worth $40.

NEW LOCALITIES IN GEORGIA AND IN ALABAMA.

Mr. W. M. Scott wrote September 2, 1899, concerning the occurrence of this moth in his State saying, among other things, that he had received specimens from Tifton, Ga., a locality not previously mentioned, and that the pest was injurious that season as also in former years. Owing to the crop about Augusta being so badly infested last season, the truckers there planted scarcely any turnips the present season, and for this reason, probably, the cabbage webworms were not noticed to be very numerous in that vicinity. On an experimental plat of Mr. Scott's at that place, however, these insects appeared to be as numerous as last year.

September 9, 1899, Mr. F. S. Earle sent specimens of the larvæ of this species, with the accompanying information that it was injurious to turnip seedlings at Auburn, Ala., and had been very troublesome for the past three seasons, its presence being noticeable in the fall of the year. The species was stated to have practically ruined the turnip crop in many gardens.

September 11 Mr. Thomas I. Todd, Athens, Clarke County, Ga., wrote of the appearance the past summer of this webworm, which he described as very destructive on cabbage, turnip, etc., and September 18 specimens of the insect were received from the same correspondent. Our correspondent stated that turnips once infested by being attacked at the bud never made good growth afterwards. The species was referred to as the "Augusta webworm." The caterpillars were stated to form their webs on one side of a plant near the surface of the ground or under the end of a leaf resting upon the ground. Our correspondent had kept two hands employed since the 22d of April dusting the plants nearly every day with poisons and searching for this particular caterpillar. The loss sustained by him was placed at not less than $250. During that season 50 pounds of Hammond's slug shot were used in one week without apparent benefit, and Mr. Todd stated that if he could not check this webworm he would have to abandon the raising of cabbages and turnips. Paris green applied in the usual manner, dusted on the plants, was tried twice each week without much effect. Two acres of turnips were so badly infested that they had to be plowed under.

NOTES ON DISTRIBUTION ABROAD; SYNONYMY.

As the appearance of the species in the vicinity of Augusta, Ga., the only other locality besides Los Angeles, Cal., in which it was positively known to occur in this country at the date of publication of the writer's first article, does not appear to have been observed prior to August, 1897, it seems probable that it was first introduced in the region where now established in South Carolina and Georgia, near Charleston, and at least as early as 1895, and from there has spread to

the neighborhood of Augusta. Near Auburn, Ala., it has been known since 1897.

Of the distribution of this species, Sir G. F. Hampson, in volume IV of the Fauna of British India, published in 1896 (p. 373), says: "Mediterranean subregion and throughout the tropical and subtropical zones, except the neotropical and Australian regions." From this and the fact that the insect does not inhabit northern or middle Europe, it would appear that there is no immediate danger of its appearance in the region of our country north of the Lower Austral area.

In the same writer's Revision of the Moths of the Subfamily Pyraustinæ and Family Pyralidæ, (Part I, p. 760), from the Proceedings of the Zoological Society of London, November 15, 1898, *Botys rogatalis* Hulst. is added to the list of synonyms, with this legend in regard to distribution: "U. S. A.: Mediterranean subregion; Ethiopian and Oriental regions."

The following synonymy is recognized:

Hellula undalis Fabr., Ent. Syst., Vol. III, 2, p. 226, Herr.-Schäffer, Eur. Schmett., Vol. IV, pl. 8, f. 54.
Scoparia alconalis Walker, Catalogue, Vol. XIX, p. 827.
Leucinodes exemptalis Walk., Catalogue, Vol. XXXIV, p. 1313.
Botys rogatalis Hulst., Tr. Am. Ent. Soc., Vol. XIII, p. 149.

In the publication first cited will be found a technical diagnosis of the genus Hellula, as also a technical description of the species. Both publications are illustrated. The figure, showing wing venation and head, are here reproduced.

OBSERVATIONS OF THE YEAR 1899.

June 19, 1899, in response to request, Mr. Simons wrote that the moth had made its appearance in his garden, and sent us the first specimens seen. The moths are very rapid in their movements when in the field, and for that reason, difficult to capture. Cabbages had been almost a total failure in 1897 and 1898, owing to the ravages of this pest.

FIG. 13.—*Hellula undalis:* wing venation, head and antenna—enlarged (after Hampson).

Decrease in numbers owing to cold winter.—Of the noticeable decrease in the numbers of this insect in the early summer of 1899, our correspondent wrote, July 22, in response to our suggestion that the climatic conditions were probably in great part the cause of the decrease, that the previous winter, as with us at Washington, was unusually severe, being marked with snaps of intensely cold weather. This, in our opinion, as previously expressed in Bulletin No. 22 (n. s., p. 56), would be just the sort of weather to destroy an insect which is not as yet thoroughly acclimatized, since such sudden changes and severely cold spells are never experienced in the Old World regions which this insect is known to inhabit. The same conditions doubtless

operated at Augusta, Ga., where the species was rare, till late in August, as previously stated.

An unrecorded wild food plant.—In response to inquiry, Mr. Simons stated that this webworm was first noticed on "pussley," or "cutter grass," otherwise purslane, *Portulaca oleracea;* it was then noticed on cabbage beds, and afterwards extended its ravages to fields of cabbage and other crucifers. In confinement at this office larvæ readily fed upon purslane.

Mr. Simons writes that the larvæ feed upon the inner portion of the leaves of young cabbages between the inner and outer integuments or skins of the leaf, and that, when nearly full grown, they usually spin up a web about the heart of the plant which they enter. Specimens of young cabbage plants received about that time showed that larvæ had entered the head singly and bored down into the stalk, their presence there being manifested by webbed-up masses of dark excrement.

In our rearing cages the larvæ fed almost exclusively on the under surface of young cabbage, the youngest eating away the epidermis and parenchyma in small irregular patches, leaving one eroded space and attacking another place, very often crawling in at a hole, which they gnaw, and feeding, as our correspondent describes, between the two outer integuments. As the larvæ grow larger, at about the first molt, they begin to cover their work with webbing, and this, with the excrement which adheres to it, forms a more or less perfect place of concealment for them.

APPROXIMATE LIFE HISTORY.

From the material received from South Carolina the moths obtained by rearing served as a basis for the completion of the life history of the species as nearly as this could be done without visiting the premises where infestation occurred.

From the received larvæ, of what is at present considered the first generation of this species, moths were obtained July 22, the approximate date of the appearance of the second brood of the insect. A very considerable number of the remainder issued a few days later. A number of the moths of this lot were placed in a rearing cage July 24, when egg deposit began. The ascertained period of the egg at this time, as was previously stated, was three days. Pupæ were first obtained August 14, which gives eighteen days as the larval period. The pupal period lasted six days, which brings the entire life cycle for this time to twenty-seven days. The weather for this period was seasonably hot, and this is not far from the minimum period that would be required for development in the Southern States also.

THE EGG AND OVIPOSITION.

A pair of moths newly bred were placed in a vial July 24, and next morning the female was found to have deposited singly, doubly, and in masses of from 3 or 4 to 20, a total of 235 eggs. The following day 24 were laid; on the 27th, 37 were found, or 296 in all. Afterwards the moth died, having laid no more. A few eggs were found upon dissection, making the probable number usually deposited between 300 and 350.

Most of the moths die in confinement within a week.

The egg.—The egg is of sufficiently large size, about four one-hundredths of an inch in length, as to be readily discernible to the naked eye. It is of oval form and rather variable in contour, being usually more or less flattened upon the surface of deposit, and there is often a distinct nipple at one extremity. Its greatest width is about three-fifths its length. The color when first laid is light gray, and under a strong hand lens the surface appears to be rugose and strongly iridescent. Under a higher power the surface is found to be made up of depressed irregular areas, mostly hexagonal and pentagonal in outline.

Length, about 0.5 mm.; greatest width, 0.3 to 0.35 mm.

A day after deposition the eggs begin to take on a pinkish hue, due to light reddish spots below the surface. On the second day the embryo can be detected, the head showing as a blackish dot near one end and on the lower surface of the egg or the side of attachment.

Experiments conducted in the latter days of July, in a temperature officially rated by the Weather Bureau of this Department as moderate (indoor 80° to 84° F.), showed that the eggs hatched three days after deposition, a rather remarkably short period for a moth with a wing expanse of nearly three-fourths of an inch.

THE NEWLY HATCHED LARVA.

The larva when just hatched measures about a millimeter in length and about a twelfth that in diameter across the abdomen. The head, as is usual with young larvæ, is prominent, wider than the body, and dusky in color. The thoracic plate is also dusky and of somewhat similar subcrescentic form to the more mature stage. The body is very pale yellowish gray, nearly white, and the surface is moderately clothed with long fine hairs.

Very soon after hatching the larva shows the characteristic striæ of the more mature form. Thus larvæ 2 mm. in length are so little different in general appearance from the full-grown ones as to be readily recognized as of the same species.

NATURAL ENEMIES.

Two new parasites of this webworm were reared during the year and have been identified by Mr. Ashmead as *Meteorus vulgaris* Cress. and *Temelucha* (*Porizon*) *macer* Cress. ♀.. both hymenopterous. The former, an Ichneumonid, was reared in September from material received from Auburn, Ala.; the latter, a Braconid, issued during the latter days of July from larvæ received from Charleston, S. C.

The Tachinid parasite *Exorista pyste* Walk., previously mentioned as an enemy of this webworm, was reared October 6 from the South Carolina lot, received in 1896, and recorded in Technical Series No. 7, of this Division, page 14, although the host was not known at that time by its specific name. An effort was made to ascertain the past year if any new species of parasitic or predatory insects were useful in destroying this webworm, but none of the several lots of larvæ which were sent from different localities and kept in our rearing jars for the purpose were parasitized. It is quite probable that in the course of time many of the various known parasites of other crucifer-feeding caterpillars will be found to attack this webworm, but for this we may have to wait perhaps for several years before parasitic or other natural enemies will be of any service as mediums for its reduction.

REMEDIES.

At the present writing nothing new has developed in the line of methods of control. It is suggested, however, that in view of the unusual destructiveness of this insect that some such methods as are in use against the striped cucumber beetle be employed, for example, the planting of an excess of seed with the aim of afterwards destroying those plants which are injured by this webworm beyond redemption.

Cabbage and turnip appear to be the favorite crop plants affected, though collards and radishes are also attacked: and it seems probable that these could be advantageously used for the protection of beets and vegetables other than Cruciferæ, which future observations will probably show are affected by the insect. The trap crop should be freely sprayed with Paris green, and the main crop could be sprayed with kerosene emulsion. Mr. Simons writes that a mixture of kerosene oil and soap sprayed upon the plants served as a deterrent against the moth, but that they returned as soon as the odor of the kerosene had become dissipated. Kerosene emulsion properly prepared and applied often enough to insure a permanent odor should be effective.

One point must be emphasized if we expect to meet with success in combating this insect, and this is that work must begin upon the first appearance of the insects each season, as what is done then will very materially affect injury for the entire year. Injury might be considerably lessened if a practice were made of pulling up and destroying

all badly infested plants before the issuance of the first new brood of moths. From current reports during the year it would seem that the proper time to begin this work is about the middle of July, as the larvæ are then nearly mature and the moths appear soon afterwards.

THE COMMON RHUBARB CURCULIO.

(*Lixus concavus* Say.)

Residents of the Eastern States who are familiar with the appearance of growing rhubarb or pieplant (*Rheum rhaponticum*) can not fail to have noticed that stalks here and there are often injured, so that the juice exudes and, drying, forms clear tear-like drops. Closer examination will show that these drops exude from holes gnawed by an insect, and if one should seek the culprit he will not be long in tracing the cause to a large rusty-coated, long-snouted beetle known as *Lixus concavus* Say, and which we may call the common rhubarb curculio to distinguish it from another closely related species, *L. mucidus*, which has similar habits.

May 9, 1899, the great numbers of beetles of *Lixus concavus* in a plat of rhubarb at Tennallytown, D. C., attracted the writer's attention and led to further study of its life economy and the preparation of the present paper. Almost every stalk of rhubarb had been attacked and some so badly as to interfere with their sale, at least to many would-be purchasers. One of these stalks served as the model of the illustration here presented as figure 14.

FIG. 14.—Stalk of rhubarb injured by *Lixus concavus*—reduced one-fourth (original).

According to the published statement of Mr. F. M. Webster (Proc. Ent. Soc. Wash., Vol. II, p. 339), the insect treated by Dr. C. M. Weed in publications of the Ohio Agricultural Experiment Station (Bul. No. 6, Vol. II, p. 153, and Bul. No. 8, Vol. III, 2d series, pp. 232–235) under this name is not the true *concavus*, but *mucidus*. The investigations which have been conducted during the year, however, indicate that this is a matter of scientific

interest rather than of economic importance, as the two species show close similitude in the details which go to make up their life histories.

DESCRIPTION OF THE SPECIES.

The adult.—The adult or mature form of this insect is a snout-beetle or curculio of the typical rhynchophorus family, Curculionidæ. It is one of the largest species of its kind, measuring from the tip of its long snout about three-fourths of an inch in length and is about three-sixteenths of an inch in width. The body and head together are about five-eighths inch long and the snout nearly three-eighths. The snout is cylindrical, black in color, and grooved on the sides for the reception of the scape of the antennæ. From other related genera the species of Lixus may be distinguished by the pollinose substance with which their bodies are covered. The covering of

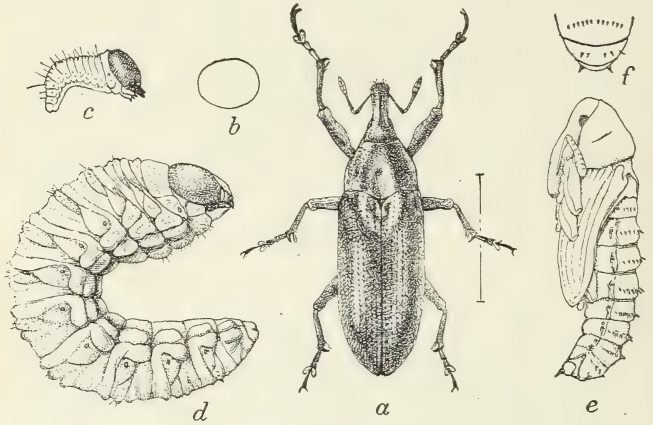

FIG. 15.—*Lixus concavus: a*, beetle; *b*, egg; *c*, newly hatched larva; *d*, full-grown larva; *e*, pupa in profile, showing dorsal motorial spines; *f*, dorsal view of last abdominal segments of pupa—all about twice natural size (original).

Lixus concavus is very bright yellow, and the writer has kept hibernated specimens for two or three months that retained this pollinose covering, which he considers pubescence. It readily rubs off, however, when the insect is handled. The elytra are of remarkably firm consistence, so hard, in fact, that it is difficult to impale the beetle with an ordinary insect pin. From other species of the genus, *concavus* is to be distinguished by the deep triangular concavities at the bases of the thorax and elytra. The prothorax is just perceptibly wider than long, moderately rounded at the sides, and distinctly constricted apically.

In the male the snout is shorter and the antennæ are inserted about one-fourth from the apex, while in the female they are placed about one-third from the end. The female is represented in figure 15 at *a*.

Lixus mucidus, the only other species known to attack rhubarb, is

larger and more robust, with stouter snout. The body is clothed with fine gray pubescence.

DISTRIBUTION.

LeConte and Horn merely credit this species to the Atlantic district. From specimens in the National Museum and other local collections and from published and divisional records the following list of localities is taken:

Stratford, Conn.; Buffalo, Ithaca, Long Island, New York, N. Y.; "more or less common throughout the State" of New Jersey (Smith); Blooming Valley and elsewhere in Pennsylvania; Columbus, Ohio; District of Columbia; Cabin John, Marshall Hall, River View, and Travilah, Md.; Rosslyn, Va.; Cadet and elsewhere in Missouri; New Ross and Lafayette, Ind.; Detroit and Port Huron, Mich.; Lawrence, Kans.; Iowa City, Iowa (Wickham); Retreat, N. C.; Lake Ponchartrain (Summers) and elsewhere in Louisiana; Minnesota (Lugger); Grimsby, Ontario, Canada (Pettit).

This is a surprisingly short list of localities considering how common the species is known to be. It is obviously an Austral, or, more properly speaking, Carolinian, form, being found apparently in much greater abundance in the Upper than in the Lower Austral life zone. It also occurs in the Transition, but in the Transition of the Middle West, as for example in northern Illinois, it is replaced to a considerable extent by *L. macer*, while in Texas it gives place to *L. læsicollis* and other species. Its known western range does not extend beyond the Mississippi Valley.

DESCRIPTIONS OF THE EARLIER STAGES.

The egg.—The egg is of somewhat variable oval form, the usual proportions of width to length being about four-sixths, the extreme reaching five-sixths; surface smooth, polished, with no visible sculpture; color dull, pale yellow; contents completely filling the shell, leaving no translucent spaces at ends; consistency of moderate firmness. Length, 1.50 to 1.90 mm.; width, 1.25 to 1.30 mm. An egg is shown in outline in figure 15 at *b*.

The newly-hatched larva.—The larva when just hatched presents the appearance of *c*, figure 15. The head is extremely large in proportion to the remainder of the body, the mouth-parts, particularly the mandibles, being especially prominent.

The mature larva.—The larva when full grown appears as shown at *d*. It measures, when in the curved position common to the Curculionidæ and shown in the figure, about 10 mm. When fully extended the length is about twice that, 21 to 23 mm., according to Webster. The width is between 4 and 5 mm. It is of nearly cylindrical form,

flattened on the extreme ventral surface. The color is milk white, the head being light brown and the mandibles dark brown, nearly black. The first thoracic segment is marked with a light yellow transverse chitinous patch resembling the cervical shield of many caterpillars. The head is nearly circular in outline, and is ornamented by an inverted Y mark. The mandibles are short and strong, concave on the inner surface, and bidentate at the tips. The leg pads are moderately prominent, and rather sparsely covered with short yellow bristles. With the assistance of the figure a more detailed description may be dispensed with. Full descriptions both of larva and pupa have been published by Mr. Webster in his article in Entomologica Americana (Vol. V, p. 14).

The pupa.—The pupa shown in the illustration at *e* in profile is of the same white color as the larva. It is somewhat remarkable on account of the row of retrorse spines on the back of each abdominal segment. The first or cephalic row consists of shorter and finer spines, and the last row of only four, in pairs on each side of the middle (see fig. 15, *f*). The terminal segment ends in two spinelike processes on the ventral side. The length is 14 to 15 mm.

The pupa cells are broad and ample, varying somewhat in length from two to three or four times the length of the pupa itself. Cells before the writer measure from 5 to 7 mm. in width and from 25 to 40 mm. in length. By means of the rows of spines on its back the pupa is enabled to work its way readily up and down from one end of its cell to the other.

The majority of the cells examined were constructed just beneath the surface of the earth, the top of the cell lying level with the earth's surface. Cells often, therefore, extend into the roots and appear to be deepest where the plants are short and dry, and dry up early. No special point appears to be selected by the larva for gnawing away an exit place for the imago, but the stem is so weakened near the bottom of the cell that it breaks at this point if pulled, and it doubtless cracks and breaks in time with the drying of the plant, so that the beetle when fully matured and ready for exit has no difficulty in effecting its escape.

BIOLOGIC LITERATURE.

For so common an insect as is this curculio, published accounts bearing on its habits and life history are few in number.

The first notice of its food habits is that given by Townend Glover in the Report of the Commissioner of Agriculture for the year 1865 (1866, p. 90). Reference is there made to the beetle having been observed "burrowing into the footstalk of the rhubarb or pie plant and then depositing a single egg in each hole." No larvæ were reared, but the opinion was expressed "that if the yellow decaying leaves of the

rhubarb were examined many of them would be found to have been injured by this insect." Five years later the same writer, in his report as Entomologist (loc. cit., 1870 [1871], p. 71), gives another short account of this insect, with an illustration of the adult.

After the lapse of another five years Dr. George Dimmock (Standard Natural History, Vol. II, p. 343) refers briefly to the occurrence of the species on the dock *Rumex orbiculatus*.

Discarding the two articles of Weed for the reason previously mentioned, we come to the very full account of this insect by Mr. Webster, published in Entomologica Americana in 1889 (Vol. V, pp. 12–16). In this article wild sunflower (Helianthus) is mentioned as a food plant in central Illinois. The egg, larva, pupa, and oviposition are fully described, and other notes are given on the life history of the species. It is quite singular that larvæ in this case were found only in Helianthus, a genus of plants upon which the insect has not been observed by any other writer to my knowledge. On page 16 of the article referred to Mr. Webster states that in a single case he observed a female ovipositing in Silphium, or rosin weed, and states that the adults feed also upon the foliage.

In volume VI of Entomologica Americana (p. 169) the writer referred briefly to the occurrence of this species on a common broad-leaved variety of dock (Rumex) and less often on rhubarb.

In Mr. Webster's article on the food plants of the genus (Proc. Ent. Soc. Wash., Vol. II, pp. 339–341) nothing new is added of this species other than the correction referred to in the opening lines of this article.

DIVISIONAL RECORDS.

May 18, 1883, we received from Mr. J. G. Barlow, Cadet, Mo., a leaf of rhubarb showing punctures of this curculio on the midrib.

November 25, 1885, Mr. F. M. Webster sent from Lafayette, Ind., stems of Helianthus from which this insect was later reared.

May 19, 1887, we received from Mr. W. B. Alwood, then at Columbus, Ohio, stems of rhubarb in which this species had oviposited.

June 5, 1895, Mr. F. V. Braymer, Blooming Valley, Pa., sent specimens of the beetle discovered on the yellow dock. June 20 Dr. Homer Bowers, New Ross, Ind., sent beetles, with report that they were observed on the foliage of growing rhubarb.

July 26, 1896, Mrs. R. H. Russell, Stratford, Conn., reported finding this species upon a dwarf sunflower in her garden.

May, 1898, Mr. F. M. Webster reported receiving this insect, with a species of Sphenophorus or "bill bug," with statement that they were injurious to corn. We have also received similar reports, the beetles being included with Sphenophorus. This is merely mentioned to show that there is some slight similarity between the species of

Lixus and Sphenophorus, these genera being of about the same average size, but not at all likely to be mistaken by anyone who studies the subject of entomology.

FOOD PLANTS.

As already shown, this species does not develop in rhubarb. The only larval food plant observed by Mr. Webster in central Illinois and Indiana was wild sunflower, *Helianthus grosseserratus*, a common Western plant. In and about the District of Columbia, as well as in the vicinity of New York City and Ithaca, N. Y., this curculio was observed only on rhubarb and dock, and the latter is the favorite and apparently the only larval food plant about Washington. It is probable that all species of Rumex having suitable stems for the development of the larva are utilized for this purpose. The species from which the beetles have been reared are curled dock (*Rumex crispus*) and broad-leaved or bitter dock (*R. obtusifolia*).

Lixus concavus is the only species observed on Rumex or rhubarb in this vicinity.

The adult of this curculio feeds upon the foliage of all of the plants mentioned, usually by gnawing the edges of the leaves, but it seems probable that a considerable quantity of nourishment is also taken when the stems are punctured for oviposition, if indeed they are not often punctured, as seems most likely, for food alone.

THE INSECT'S LIFE HISTORY.

Hibernation and time of appearance.—This rhubarb curculio hibernates as a beetle in and near the District of Columbia, and is one of our early arrivals, appearing in the field some time in April, presumably with the appearance of its food plant, or about the time that the stems are large enough for oviposition. Pairing and egg deposit begin soon afterwards.

From the scarcity of beetles in the field after the dying out of the hibernating generation in the summer, the writer had formed the opinion that beetles overwintered in the stalks, and particularly because Mr. Webster had found that hibernation also took place in other stages (larva and pupa) in the localities where he had made observations. It was therefore surprising that in spite of several attempts, made at intervals between the second week of September to the second week of October to find beetles, none could be found in stems in which there was evidence that they had developed.

A beetle that issued August 12 was kept for upwards of two months without food. October 18 a beetle was captured in the field that had evidently been flying, and this, together with the beetle reared in confinement, were placed in a jar with dock leaves October 18. The latter

died in a day or two without feeding, while the other fed freely in the accustomed manner on the edges of the leaf.

Everything considered, this is tolerably good evidence that, in spite of the rarity of the beetle of this species in the field or the difficulty of finding it in autumn, it does, at least occasionally and perhaps normally, issue from its burrows to feed before seeking a new place for hibernation.

ON THE HABITS OF THE SPECIES.

The eggs are deposited singly in little oval or elliptical cavities measuring about 2 mm. in width and 4 or 5 mm. in length, and constructed in the stems at a depth of between 2 and 3 mm. beneath the skin. In thin stems of dock the egg is deposited loosely through the hole made by the parent beetle in the hollow of the stalk.

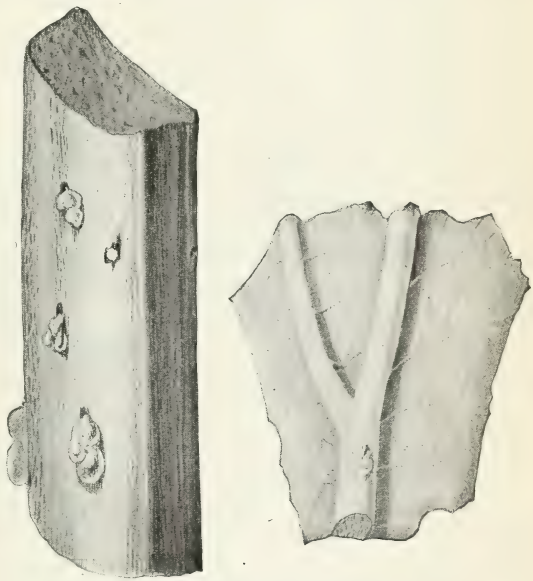

FIG. 16.—Section of stalk and of leaf of rhubarb, showing attack of *Lixus concavus*—natural size (original).

Egg deposit evidently takes place by preference in the young flower-stalks, but as it is the custom of many gardeners to cut these off early in the season, the beetle is forced to lay her eggs in other parts of the plant; hence it follows that eggs are quite as often found in the main stems, the crown of the plant, and even in the larger veins of the leaves. A great many more punctures are made in the stems of rhubarb, particularly early in the season, than are necessary for deposition of eggs. In the section of rhubarb stalk illustrated at fig. 16, taken from the field in early May, all of the punctures appear to have been made either for food or else the insect was deterred from depositing her eggs by the presence of too copious exudations of juice.

In dock the egg punctures occur from near the bases of the stems far toward the tops, and nearly always contain eggs or larvæ. Dock stems sometimes contain as many punctures as in the rhubarb stem of the figure. Later in the year, even by the first week of June, eggs are nearly as often found in rhubarb, particularly in the flower-stalks.

The species of Lixus are long-lived, and it follows that oviposition

extends over a considerable period. Here in the District of Columbia the present year the first beetles that were noticed appeared late in April.[1] Larvæ were first noticed hatched May 11, but eggs were still to be found late in June.

Eggs deposited May 11 and 12 hatched May 19 and 20, or in eight days, the weather during this time being seasonable.

Larval habits.—The plants of dock on the Department grounds upon which beetles were placed were carefully watched and the stems and roots were pulled up for examination from time to time, but, unfortunately, the ants which were associated with aphides at the roots entered the burrows and killed the larvæ, thus interrupting our experiments. Stems of dock were also examined in the neighborhood about the District of Columbia and larvæ were found to approach maturity during the first and second weeks in July. July 22 an immature beetle was found in its burrow, larvæ and pupæ also being present in that vicinity at this time. The duration of the larval stage, although not definitely ascertained, is not far from two months.

It is probable from all that could be learned that larvæ begin to approach maturity about the first or second week of July.

Beetles put in our rearing cages in early May lived through June till about the middle of July, some, however, dying earlier; in other words, some of the hibernated beetles are still living within a few days of the time of the first appearance of the new generation.

In the stems of dock examined, only a single Lixus was found to develop in a stem. Often a dozen or more punctures are made in a stem and nearly as many eggs are deposited in some cases, but one larva only develops. What becomes of the other larvæ is a problem. Presumably they fall a prey in many instances to predaceous insects, particularly ants, but when they are not so destroyed it would seem that they either die from being shut off by the larva nearest the roots into the upper portion of the plant, where they succumb with the dying of the stem, while the lowest larvæ, having an abundance of moist food, survives. Very often the larvæ bore down into the root, evidently being driven to this expedient by the drying of the stems above.

Life cycle still incomplete.—From the above it will be seen that the full life cycle is not yet known. The egg stage, as previously observed, was eight days in seasonable May weather. The observed duration of the pupal period in the hot weather of July was also eight days. The observations on the life cycle period, and hence the larval period, which could readily have been made out by deduction, were interrupted by the ants.

The species does not appear to develop in rhubarb.—If the larva lives at all in rhubarb this fact has escaped observation. Many eggs fail to

[1]This is true, also, of *L. mucidus*, according to Weed.

hatch, presumably being destroyed by the superabundance of juice which exudes from the plant where egg deposit takes place, while the larvæ, if they hatch at all, meet death in the same way.

Of all of the many thousands of eggs of this species that were deposited within a few miles of the District of Columbia it is obvious that only hundreds produced beetles. None that were deposited in rhubarb appeared to develop. A large percentage that were laid in dock and that produced larvæ also died before attaining maturity. In addition to ants, parasitic insects must have destroyed their quota of larvæ. So it follows that, taking into consideration the number of beetles that fail to survive the winter, the species, compared with many others that could be mentioned, leads quite a precarious existence.

NATURAL ENEMIES.

Mr. Webster, writing of this curculio in stems of Helianthus, remarked that a great many of the larvæ were devoured by woodpeckers. Dr. Weed recorded the rearing at Columbus, Ohio, of a hymenopterous parasite of *Lixus mucidus*, *Bracon rugator* Say. These parasites develop at the expense of the larvæ, feeding externally upon them. When mature they spin brown silken cocoons in which to transform. As several Braconids are known to be parasitic on other species of Lixus feeding like the present one in stems, it is probable that one or more species attack *Lixus concavus*.

REMEDIES.

The use of arsenicals or other poisonous insecticides upon rhubarb during its growing season is of course out of the question. Fortunately the nature of the injury by the species is not as a rule serious. When, however, this curculio occurs in troublesome numbers it can readily be controlled by other methods. The beetles are so large and conspicuous, and so often occur freely exposed in the bright sunlight on the leaves, that they are easily detected, and as they are sluggish and do not fly readily there is no difficulty in capturing them. The proper time for this is upon the beetles' first appearance. It would be well also to gather the beetles upon near-by plants of dock, and after the eggs are deposited these plants should be pulled up and burned. In the District of Columbia and in similar latitudes the beetles are to be looked for toward the end of April and first of May, and the docks which serve as a trap crop should be destroyed about the first of July, as most of the eggs have been deposited by that time.

THE STRAWBERRY FLEA-BEETLE.

(*Haltica ignita* Ill.)

One of the periodical visitants of the strawberry bed, and an insect that can, in its periods of abundance, prove quite troublesome, is a Chrysomelid beetle, known in literature as the strawberry-leaf flea-beetle, or fiery flea-beetle. It has also been called the apple flea-beetle and the lesser grapevine flea-beetle, and is now known scientifically as *Haltica ignita* Ill., though often mentioned in text-books and agricultural works under the name of *Graptodera ignita*.

The periodicity of attack of this insect, coupled with the fact that it is not confined to strawberry, but feeds on a variety of other plants, including weeds—its natural and preferred larval food plants—render it unlikely that it will ever become of the highest importance. Of its capabilities for destruction more will be said under the chapters devoted to recorded injuries and literature and unpublished records of injuries.

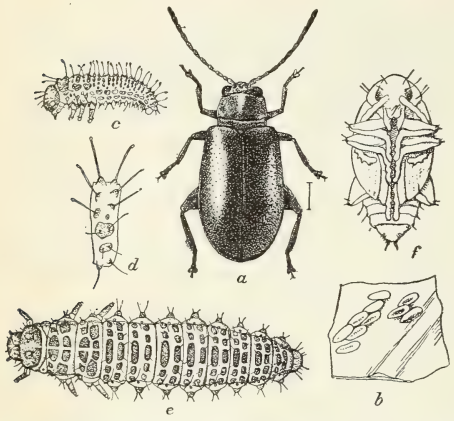

FIG. 17.—*Haltica ignita: a*, beetle; *b*, egg mass on bit of leaf; *c*, newly-hatched larva; *d*, first abdominal segment of same greatly enlarged; *e*, larva; *f*, pupa—all except *d* about eight times natural size (original).

DESCRIPTION OF THE SPECIES.

The strawberry flea-beetle belongs to the typical genus Haltica, of the tribe Halticini, or flea-beetles, a genus which includes 24 described species, most of them of a uniform greenish or bluish color, and all provided, as are other flea-beetles, with powerful, dilated hind femora. By means of their strong hind-legs the beetles possess an unusual saltatory power, which has given them the common name of flea-beetles.

Haltica ignita was given its scientific name by the German entomologist Illiger in the year 1807 (Magazin für Insectenkunde, Vol. VI, p. 117). It was described later under the specific names *kalmiæ* Melsh. and *inærata* Lec., and mention is made by Melsheimer and LeConte of two MSS. names, *cuprea* Melsh. and *splendida*, by which the species was also known in collections.

The various species of Haltica are difficult of determination without the aid of full descriptions and a large series of specimens, including the males. *H. ignita* is one of the smaller species and belongs to the same group as the grapevine flea-beetle, *H. chalybea*, which has the thorax with an antebasal groove extending entirely across. In the

present species the groove appears to vanish at each end, but this is apparent only. The punctuation of the elytra is coarse. The general appearance of the insect is illustrated at figure 17, *a*. It is of oval, slightly oblong form, and is remarkable on account of its extreme variability of coloration, the color of different individuals ranging from bright metallic golden, coppery, golden brown or purplish, to green and blue. The variation in color is of unusual interest, as it is influenced by climate and determines to a great extent the range of the species, this fact being so striking as to have attracted the writer's attention long ago and to have received special mention by Dr. Horn. The more northern individuals are the more brilliant golden-hued ones. About the District of Columbia the green ones are apparently more abundant, and are the prevailing types southward, deep blue becoming the characteristic color of the specimens taken in the Gulf States. It may be significant that the beetles observed by the writer before the middle of August the past season were mostly green and those observed in the same locality after that date were metallic. The latter, however, are not nearly so brilliant as those occurring farther north. The Northern individuals are, as a rule, larger than the Southern ones.

DISTRIBUTION.

The strawberry flea-beetle is a native American species and of such remarkably wide distribution as to have created remark by Mr. Martin Jacoby, a European authority on Chrysomelidæ.

The distribution of this species accorded by Horn, who gave a full technical description on page 221 of the Transactions of the American Entomological Society for 1889 (Vol. XVI, p. 221), is from the Hudson Bay region to the New England States, south to Texas and Florida.

The following locality list has been compiled from published and unpublished records, the latter, which includes most localities mentioned, being founded on material in the National Museum and the writer's own collection. It shows a range extending from ocean to ocean and from north to south of Canada to Mexico.

Newport, R. I.; Ithaca (July 5–9), Peekskill, Port Richmond, Staten Island (June 3), Carys Mills, Floral Park, N. Y.; Orange (at light), Highlands (June 18), and elsewhere throughout New Jersey; River View, Goldsboro, Marshall Hall, Md.; Norfolk, Rosslyn, Cherry Dale (June 3–July 11), Va.; District of Columbia; St. Louis, Mo.; West Point and Nebraska City, Nebr.; Columbus, New Albany, Indianapolis, Ind.; White Bear Lake, Minn. (Lugger); Waco, Cypress Mills, and Beeville, Tex.; Tempe, Ariz.; Orlando, Oviedo, Lake City, Valkaria, Waldo, Fla.; Easton, Wash.; Colorado; Sacramento, Cal.

To the above list there should be added: Atoyac and Vera Cruz, Mexico (Jacoby); Fort Simpson (LeConte) and Fort Rae (Wickham), Northwest Territory, Canada.

The egg.—The egg is subcylindrical, and in outline rather irregularly elliptical, being about two and one-fourth times as long as wide at its greatest diameter. From the egg of *Disonycha xanthomelæna*, a flea-beetle which was figured and described in its different stages in Bulletin 19, n. s. (page 81), and which it somewhat resembles, it differs in having the ends reversed. It is narrower at the base, where it is somewhat irregularly rounded and longitudinally wrinkled on one or two exposures and is broader and more rounded at the apex. The color when newly deposited is pale yellowish buff, changing but little before hatching. The surface is opaque and the sculpture recalls that of Disonycha, but is more or less obsolete, in some eggs being very indistinct.

Length, 0.72 to 0.78 mm.; width, 0.32 to 0.35 mm.

The eggs are deposited in groups of two or three to twenty or more, side by side, in the manner shown in the illustration (fig. 17, *b*). They are rather firmly attached at their bases and lie upon the leaf nearly flat, but with their apical ends free. A very large proportion of the eggs obtained in confinement were streaked lengthwise with a thin line of excrement, and this would appear to be a normal habit of the female of voiding a small quantity of her fæces on each egg.

The newly hatched larva.—The larva when just hatched has the appearance represented at *c* of figure 17. It is subcylindrical in form and rather dull, dirty-looking honey yellow in color. It tapers strongly toward the posterior extremity and is widest near the middle. The head is large and prominent, with prominent three-jointed, conical antennæ. The legs are long and the body is covered with long gray and black hairs. The hairs proceeding from the head, and the longest of those which proceed from the sides of the prothorax and the lower portions of the sides of the abdominal segments, are normal and pointed. The majority of the remainder—those on the sides of the thorax and abdomen and at the ends—are bulbous or capitate, as is often the case with post-embryonic larvæ. The hairs proceed from tubercles which are only moderately prominent as compared with those of other related species. The second and third thoracic segments bear above two pairs of rather conspicuous black tubercles. The dorsal tubercles are also mostly black, small, and rather inconspicuous. The hairs proceeding from these are also black. The anal proleg is large and prominent and assists the larva in locomotion.

Length, 0.9 mm.; width, 0.4 mm.

The mature larva.—The larva resembles that of *Haltica chalybea*, the two possessing many features in common. That of *ignita*, when full grown, varies somewhat as regards the ground color, some few being dull yellowish, but more often the general color is dark olive, sometimes so nearly black that the tubercles can scarcely be dis-

tinguished, giving to the body a nearly uniform dull black color. The shape is subcylindrical, well-rounded above and depressed ventrally. The body tapers about equally toward either extremity, the diameter being greatest near the middle. The length is about four times the width. The surface of the body, both above and below, is very finely guttulate and very closely covered with large, dark tubercles, or tuberculous spots of various shapes. Some are single and some confluent, and bear, some one and some two hairs, the various patterns which they form on the dorsum being indicated in the illustration. All the tubercles appear black on the living larva, but in alcohol they turn dull greenish brown.

The head is rounded in outline, the lobes moderately constricted posteriorly and are indicated by a wide, shallow, median depression. The color is moderately shining black, with white sutural lines showing about the antennæ and mouth-parts, the inverted V mark is white and very thin. The hairs, which project a few forward and a few diagonally from its surface, are dark brown. The antennæ are black, and very short. The three pairs of thoracic legs are mostly black, like the antennæ on the exterior surface, and mostly gray on the interior, being for the most part gray toward the base and black apically.

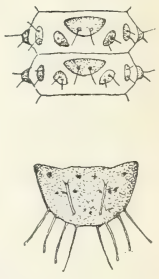

Fig. 18.—*Haltica ignita:* ventral view of 1st and 2d abdominal segments, above; dorsal view of anal segment, below—both enlarged (original).

The thoracic plate is of the same ground color as the other tubercular surfaces but spotted with dark brown, and is surmounted with similar hairs. It has somewhat the appearance of being made up of several smaller tubercular spots. The median tubercles of the second and third thoracic segments are simple, but those of the abdominal segments are confluent and form an elongate, oblong transverse band. The anterior confluent pairs are about a third wider than the posterior. The tuberculiferous spots of the second and third thoracic are separated above by a narrow line moderately curved posteriorly.

The tubercular spots of the abdominal segments are arranged in moderately regular rows of eight; those above the spiracles being arranged in double and parallel rows; those below in single rows. All tubercles are prominent, the lateral being the largest and the dorsal the smallest. The tubercles above the spiracles bear each a single hair, blunt at the apex; the tubercles below the spiracles bear each two acutely pointed hairs, placed closely together.

In figure 18 the arrangement of the tubercles on the ventral surface of the first and second abdominal segments is shown above, and a dorsal view of the anal segment is given below. The anal proleg is moderately prominent and nearly white on its exposed surface.

Length of full grown larva extended, 5 to 5.6 mm.; width, 1.3 to 1.4 mm.

The pupa.—The pupa (fig. 17, *f*) in its structure presents no very observable characters for recognition. It looks like that of *Disonycha xanthomelæna* but differs in color. It is quite differently colored from its larva, being rather pale orange, with lighter yellowish orange head, legs, and wing-pads. The surface is rather sparsely beset with short, fine, acutely pointed hairs, light at their insertion and nearly black at the apices. These proceed from small, dark, rounded, moderately prominent piliferous warts or tubercles, in the arrangement of which there should be found good generic, if not specific, characters. One of these tubercles is located on the head near the inner angle of each eye, and another is placed above it and a little nearer the median line. A transverse row of hairs proceeds from the posterior end of each abdominal segment. The abdomen terminates in a pair of apical hooks, which are moderately acutely pointed and rather strongly incurved, nearly white in color at the base and black upon the posterior moiety. There is also on the ventral surface at each side of the anal aperture a minute tubercle.

Length, 3 mm.; width, 1.6 mm.

PUBLISHED BIOLOGIC RECORDS.

In the year 1847 Dr. F. E. Melsheimer gave to this insect the specific name of *kalmiæ* from its occurrence on the laurel, *Kalmia latifolia* and *glauca* (Proc. Acad. Nat. Sci. Phila., Vol. III, p. 164).

What appears to be the earliest record of injury to any useful plants by this species is that published in Volume III of the American Entomologist in 1880, and reported by Mr. G[eo]. T[hurber]. The beetles were described as having injured fuchsias at Norfolk, Va., in June of that year, when they swooped down "in a cloud," and in two hours ruined over 600 blooming plants; no other plants were noticed to be affected. Paris green killed the beetles, but unfortunately also injured the plants so that they could not be sold. In the answer to this letter by Dr. Riley, the species is identified as *Graptodera carinata* Germ., and the present identification of the species as *ignita* is on the authority of Mr. Schwarz. Incidental mention is made of the species having been found very injurious to fuchsias at St. Louis in 1874, and that it attacks also many other greenhouse plants. First appearance was noticed during the month of June. The egg was briefly described. The beetles were also stated to often swarm on fireweed (*Erichthites hieracifolia*). Pyrethrum "numbed" the insects and kept them off the plants until it was necessary to water them again. Beetles were reared from larvæ found feeding on evening primrose (*Œnothera biennis*).

It was not until a decade of years prior to the time of writing, so

far as can be ascertained, that anything was published concerning injury by the species to strawberry or other edible crops. In the year 1889 there was published in Insect Life (Vol. I, pp. 220, 221) a note from correspondence on injuries by the beetle to the tender leaves of grape at Tempe, Ariz., in April, 1886.

This was followed the next year by several publications concerning this flea-beetle, which will be briefly mentioned :

A line note on the occurrence of the species on Kalmia, at Peekskill, N. Y., early in May, by Mr. John D. Sherman, jr. (Proc. Ent. Soc. Wash., Vol. I, p. 162).

A second letter from the correspondence of the Division (Insect Life, Vol. II, pp. 369, 370), a complaint of injury by Mr. W. E. Hudson, Orlando, Fla., March 27, 1890. The beetles appeared on this correspondent's strawberries in thousands, and all the berry fields in the neighborhood were infested. They were also noticed on weeds of different species and on peach trees. They fed on the leaves from the upper side, eating off all the green part and leaving only the skeleton.

A short note by Dr. James C. Neal, stating merely that this flea-beetle had been the source of much trouble to strawberry growers in various sections of the State of Florida (Bul. 9, Fla. Agr. Exp. Stat., p. 11).

A note by Prof. Lawrence Bruner (Rept. of the Entomologist, Nebr. State Horti. Soc. for 1890, p. 23) containing, however, no original observations.

The following year, 1891, Prof. F. M. Webster (Bul. 33, Purdue Univ. Agr. Expt. Sta. Ind., p. 44) wrote of injuries by this insect at Columbus, Ind. What is practically a reprint of the last-mentioned note appeared the following year (Trans. Ind. Horti. Soc. for 1890 [1891], p. 25). This was followed by an article by Mr. Webster on the occurrence of this species at New Albany, in southern Indiana, reciting injury to strawberries, and including mention of damage occurring as far north as Indianapolis. July and August were the months noted as the ones in which the beetles were most destructive, they seeming to disappear from the field about the 1st of September. A note by Mr. E. A. Schwarz (Proc. Ent. Soc. Wash., Vol. II, p. 183) appeared next, giving a review of observed food plants of the beetle. He remarked, among other things, that the imago appears to be more polyphagous than any other species of its genus, and that *Œnothera biennis* seemed to be the only true food plant ascertained for the larva up to that time. Brief mention was made in Volume V of Insect Life (p. 17) of injury that has previously been mentioned, adding, however, two new localities for the species—Lake City, Fla., and Waco, Tex. Omitting mere mention of the occurrence of this species on Kalmia by Dr. J. Hamilton, we come to an article published by Mr. A. L. Quaint-

ance in 1897 (Fla. Agr. Sta., Bul. 42, p. 592). No original observations were made, which is true of a note published by Prof. C. P. Gillette in Bulletin 47 of the State Agricultural College Experiment Station of Colorado (p. 5).

In Dr. Otto Lugger's fifth annual report as Entomologist to the State Experiment Station of the University of Minnesota, published in 1899, some attention is given this insect under the title of "The lesser grapevine flea-beetle." The insects were noticed by Mr. J. W. Taylor, White Bear Lake, Minn., early in the spring of 1899, eating into the buds of wild grape, afterwards attacking cultivated varieties, and later the foliage of Virginia creeper. After destroying the buds they continued upon the fully expanded leaves, which were riddled in every conceivable manner to such an extent as to destroy them entirely. Two generations were observed doing damage; the hibernating beetles commencing the work, and the larvæ and beetles of a subsequent generation finishing it. Eggs were found among the woolly substance of the partly destroyed grape buds. It is said of the species that it promises to become decidedly injurious, and therefore wherever it is found should be fought with arsenites as soon as noticed.

UNPUBLISHED DIVISIONAL RECORDS.

The unrecorded notes on injuries by this species are, like the published accounts previously noted, inconsiderable; but, such as they are, they tend to show the periodicity of attack, 1890 being a year of excessive abundance.

During 1890, specimens of the beetles were received from several localities with reports of damage to strawberry and other garden plants. April 4, from Mr. W. E. Hudson, Orlando, Fla., previously mentioned, as recorded; April 29, from Mr. John Scott, Waco, Tex., with the statement that the species was doing much damage to garden plants; September 1, from Mr. F. M. Webster, with the report that the beetles were injuring the strawberries at Columbus, Ind., also recorded.

Mr. T. L. Mead, an entomologist and a competent observer, wrote, May 4, 1897, that two or three years before that date a species of Haltica, which, from his description, is without doubt this species, "did a good deal of damage to strawberry leaves, being almost numerous enough to cover them." Locality, Oviedo, Fla. A spray of Paris green was used with apparently good results, as the next year the beetles were scarce and had not appeared at the time of writing. Mr. J. S. Lapham, Goldsboro, Md., writing of the occurrence of this flea-beetle on strawberry the same year, stated that "this insect feeds on the leaves, making thousands of small holes in them, and while it does not altogether destroy the crop of fruit, the berries are much smaller when it works."

HABITS OF THE LARVÆ.

In our rearing jars the larvæ hatched from the egg fed almost exclusively on the underside of the leaves. Not being satisfied that this was the only manner of feeding of the larva, a visit was paid to the locality where this species was found most abundantly the past season, with the result of finding some plants containing numerous larvæ. It was then ascertained that this larva lives very much as does the related *Haltica mareyagans*, which the writer has had under observation in earlier years. It feeds upon both the upper and lower surfaces of the leaf, appearing not to prefer either side. It also erodes large holes in the growing seed pods, and even at times feeds in a similar manner upon the stem. The larvæ appear to favor the shade and are usually found in the more secluded positions on the plant, particularly the upper portions, occurring quite as often on the seed pods as on the foliage. In several instances larvæ were found that had crawled into leaves that had been rolled up by the grape leaf-folder, *Desmia funeralis*. The larvæ are quite sluggish and move from one leaf to another only when necessity urges them, feeding as they go. In feeding they gouge out around them large cavities, nearly as deep as their bodies.

When full fed the larvæ enter the earth, and beneath and near the surface form little cells for pupation. Before this transformation they become much lighter, yellow or orange-yellow, in color.

LIFE HISTORY OF THE SPECIES.

The beetles have been observed in the District of Columbia in May, but probably make their appearance in the South at least in April, and farther north may not appear till early June.

Eggs were deposited on the 23d by beetles obtained at River View, Md., May 21, and by others taken August 12, at Marshall Hall, Md., on the following day and until at least the end of the month, since eggs have been obtained as late as August 28.

The observed duration of the egg stage in August was six days.

Larvæ that hatched August 18 had begun to attain maturity August 29, or in eleven days, when they entered the earth for transformation.

The first imagos appeared September 6. We know even without verification the full periods of development merely by the analogy of this species and related ones. It had required two days for the beetle to mature before leaving the pupal cell. This would bring the date of assuming the imago state to September 4. The pupa stage required eight days, and eight days more were consumed by the larva in the earth before transformation to pupa. The temperature to which the insects were exposed during the major portion of this time was moderately cool, about 74 to 84° F.

Indications are that there are two generations produced annually in the District of Columbia, and there is probably a third in the South, while farther north only a single generation may develop.

NATURAL ENEMIES.

No parasitic or predacious insects have, to the writer's knowledge, been found to attack this insect, but it seems probable that since the larva lives freely exposed on its host plant that it is preyed upon by species of predaceous and probably also parasitic insects.

On some of the plants of evening primrose upon which larvæ were observed were numerous individuals of the spotted ladybird, *Megilla maculata*, and there are the best of reasons for believing that this is a natural enemy, although none of the ladybird beetles were actually observed to attack the flea-beetle larvæ during the time that the latter were under observation in the field.

REMEDIES.

In the treatment of the strawberry flea-beetle we have to follow much the same methods as previously prescribed in the case of the pale-striped flea-beetle. As with that insect, the best remedy is undoubtedly one of the arsenicals, Paris green or arsenate of lead being among the most useful, applied preferably in the form of a spray upon the first appearance of the insects in the gardens. As Bordeaux mixture is known to be a repellent of considerable value against flea-beetles, such arsenical as is used should be mixed with this fungicide. It will then serve also to a certain extent a double purpose of protecting the plants against fungous attack.

It is not desirable to use the poisonous sprays at the time of fruiting of the crop, and at this time dusting the foliage with lime would serve to drive the beetles away.

In cases where the beetles have been injurious for two or more years in succession, it would be advisable to apply the poisons to the wild larval food plants, and afterwards to prevent these growing in abundance where they would become an infesting source. It seems probable that most instances of attack could be traced directly to the beetles having bred in great numbers upon evening primrose or related plants growing in the immediate vicinity.

THE FALL ARMY WORM IN 1899.

(*Laphygma frugiperda* S. and A.)

Among the destructive insect pests of the season of 1899, and as troublesome, perhaps, as any insect of that year, if we take into consideration the large number of crops and the great area of territory affected, was the fall army worm, or grass worm of the South (*Laphygma frugiperda*, Smith and Abbot). The season was marked by unprecedented outbreaks over a very considerable portion of the United States east of the Rocky Mountain region, injury being reported

also in Cuba. The territory infested during the year comprised portions of New York and New Jersey in the North and East, and from there southward to Florida, and westward to Texas, including among Western States, Kansas, Nebraska, Ohio, Indiana, and Illinois.

Although the species is a common one, and known to husbandmen generally as distinct from the true army worm (*Leucania unipuncta* Haw.), its life history has not as yet been studied in all its details in any single locality, to the writer's knowledge. It is hoped during the coming season to settle certain points as to the insect's life habits and economy; and as the insect is one of great and growing importance, it is proposed to bring together all the most salient facts concerning it, in the form of a bulletin, when the missing data have been supplied. In the present paper a brief account of injurious occurrences of the season of 1899 will be furnished, together with a mere outline of other matters pertaining to the insect, pending a more complete account.

The fall army worm is essentially a grass feeder, attacking grasses of all sorts, as well as the most succulent grains, but when these foods are exhausted, as happened during the past year, the caterpillars, driven by hunger, avail themselves of almost anything green, and at such times become pests in gardens, orchards, and greenhouses, as well as in the field. Although, properly speaking, a field-crop insect, this species does such considerable damage in the vegetable gardens, and to so great a variety of truck crops, that it is for purposes of convenience considered in the present bulletin.

The list of localities where outbreaks were noticed duing the year, although large, does not by any means afford ground as to a full estimate of the ravages of this pest. Many correspondents reported the "army worm" in their vicinity where it was impossible to obtain specimens of the insect. As only four reports reached us during the season of injury by the true army worm, there is every reason to believe that the fall army worm was the insect present in nearly every case. Reports of injury by this insect usually attract attention late in the season, and for this reason only a single publication on this subject, emanating from the University of Nebraska, appeared during the year.

INJURIOUS OCCURRENCES OF THE SEASON OF 1899.

The first instance of reported injury was received from a correspondent who wrote June 19 of damage to the rice crop in the neighborhood of Wilmington, N. C. In this case, as in others which will be reported, specimens accompanied the communication.

During July we received a report of an outbreak at Cherry, N. C., and of much damage to corn, rice, peas, grasses, and young corn. During the latter days of that month the writer's attention was called by Dr. P. B. Kennedy, of the Division of Agrostology, to injury to an experimental plat of creeping bent-grass, *Agrostis stolonifera*, on the

Department grounds, in which this insect was concerned, and was evidently the chief factor concerned in the subsequent death of the grass.

During August we received through different correspondents reports of injury at Arcola, Ill., to leaves of corn; at Red Springs, N. C., to corn, millet, cowpeas, sweet potato and other vegetables; at Chicago and Evanston, Ill., of much trouble caused by the great numbers of these insects to lawns in both cities, this outbreak forming the text of numerous newspaper accounts and much correspondence with this Division; attack was most noticeable, from what could be learned, on young blue grass, although the "worms" were observed also on white clover; at New Glatz, Md., to forage or sowed corn and spinach; at Rives, Md., to millet; at Evansville, Ind., to corn; at Richmond, Va., to corn and millet near that city; at Statesburg, S. C., to grass, hay, and garden vegetables; at Morgantown, W. Va., to lawns; at Clarcona, Fla., to "teosinte," *Euchena mexicana*, a forage plant resembling maize; and at Congaree, S. C., to upland rice.

In October we received report from Athens, Ga., of injury to the leaves of turnips, in which this insect was one of the species present. At Matanzas, Cuba, it was reported as being concerned in a severe attack upon pasture grasses, as well as on young tobacco. It was reported the same month as doing injury to lawns at Buffalo, N. Y., while at McPherson, Kans., it was stated to be destructive to wheat. Certain reports reached this office after the close of the year, and among these one from Mr. F. M. Webster of injury during the season at Haverhill, Buckrun, and Urbana, Ohio, and one from Prof. J. B. Smith of injuries in New Jersey, clover, grass, and wheat having been the crops attacked.

A more complete list of localities could have been furnished at this time but for the fact that the ravages of the insect were either at their height or had not been noticed at the time of the meeting of the Association of Economic Entomologists in August. Doubtless during the coming year different members of that Association in various parts of the country will write concerning the outbreaks in their respective States.

In The Indiana Farmer of September 22, 1899, this insect was reported as having made its appearance at New Lafayette, Ind., and in the vicinity of Indianapolis, corn, millet, buckwheat, and garden vegetables being the crops attacked.

In the publication of the University of Nebraska, previously mentioned (Press Bulletin, series No. 2), Prof. W. D. Hunter, its author, reported injury to be very severe in that State, particularly to alfalfa, the species having been identified from Johnson, Gage, Nemaha, Saline, Fillmore, Douglas, Washington, and Dodge counties. The presence of the species was also reported from Boyd and Dawson counties.

Other crops affected were beets, corn, Kafir corn, wheat, oats, cabbage, and grasses.

DESCRIPTIVE.

For the benefit of those readers of this bulletin who may not have access to descriptions and illustrations of the insect, brief descriptions will be furnished to serve as a means of identification in connection with figure 19.

The parent of the fall army worm is a moth and a member of the family Noctuidæ to which belongs the true army worm and the cutworms. The army-worm moth is quite unlike that of the common army worm and very variable, there usually being in most localities two distinct forms, a dull gray and an ornamented form. The former is shown in the illustration at *a*. The fore-wings are dull grayish-brown above and show in this color variety a pattern more or less like the one figured. The hind-wings are glistening white with rosy reflections. In the more ornamental form, the insect resembles one of the owlet moths, particularly *Prodenia ornithogalli*. The fore-wing of this variety is figured at *b*. The fore-wings are mottled with black and white, reddish brown, and sometimes with pale bluish, yellowish, and other tints. The wing expanse is from an inch to an inch and three-eighths.

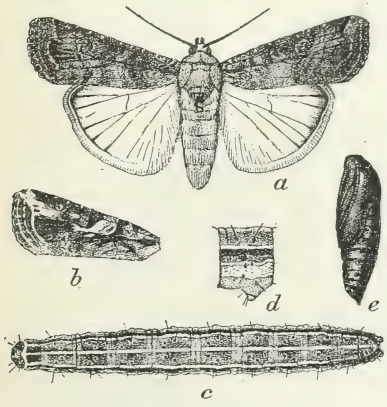

FIG. 19.—*Laphygma frugiperda: a*, moth, plain gray form; *b*, fore-wing of Prodenia-like form; *c*, larva extended; *d*, abdominal segment of larva, lateral view; *e*, pupa, lateral view—*d*, twice natural size; others enlarged one-fourth (original).

The eggs are about half a millimeter, or about one thirty-second of an inch in diameter, and are deposited in clusters of from fifty to sixty and more, often in two or three layers. The whole egg mass is covered with gray-colored down from the body of the parent moth.

The larva when first hatched is quite unlike the full-grown caterpillar, the head being proportionately larger and the body more hairy. It is nearly black at this stage. The same variability observed in the mature insect holds good of the coloring of the caterpillars. When mature they measure about an inch and a half, and while resembling the common army worm in certain particulars may readily be distinguished from that species. A full-grown caterpillar is shown in the illustration at *c*. The notable points of difference between this larva and the common army worm are in the larger and more prominent piliferous tubercles and the longer hairs of the former and in the

smaller and slenderer body. The head is proportionately smaller, nearly black, and with a white inverted Y-shaped mark in front not possessed by the army worm.

The body is striped on a ground color which varies above from pale yellowish brown, to black, more or less strongly streaked and intermixed with dull yellow. Three thin stripes of pale yellow extend along the dorsal surface through the thoracic shield to the anal extremity. The dorsal or middle line is nearly straight, and the subdorsal ones are feebly sinuate. On each side there is a broad yellow undulating line, more or less strongly mottled with red, particularly in the vicinity of the abdominal legs. The ventral or lower surface is paler, varying from dull yellow to greenish, sometimes very strongly mixed with red.

The pupa resembles that of the army worm, but is of smaller size, and the spiracles and a considerable proportion of the surrounding tissues are larger and more prominent in the former. The length in this stage is about five-eighths of an inch.

DISTRIBUTION OF THE SPECIES.

The distribution given by Dr. Smith in 1893 (Bul. 44, U. S. Nat. Mus., p. 169) is from "Canada, south to Florida and Texas, west to Missouri, Nebraska, Kansas, Jamaica, Brazil." The insect has also been reported to us from Colorado and Montana, and specimens were received during the year from Cuba.

The species is native American and probably indigenous to the United States, but has, evidently, spread from the Gulf States northward in rather recent years. At present it occupies the Tropical, Lower Austral, and Upper Austral life zones, and has been reported to occur in the Transition faunal area, and appears to be traveling slowly still farther northward.

HISTORY AND HABITS.

The fall army worm was first described in 1797, in Smith and Abbot's Natural History of the Lepidopterous Insects of Georgia, or one hundred and two years before the present general outbreak. Since that time ravages have been noticed at various periods and in different localities, in 1845, 1855, 1868, 1870, 1872, 1873, 1881, and 1883, these irruptions being noted in only one or two States in a single year.

The first outbreak of any extent occurred in 1884, followed by a smaller outbreak in the ensuing year. Later reports of injury were received in 1892, 1896, and 1897.

The list of plants which serve as food for the fall army worm during its periods of abundance include, besides grasses and grains of all sorts, sugar cane, buckwheat, alfalfa, clover, cowpeas, sugar beets, cotton, tobacco, sweet potatoes, spinach, turnips, tomatoes, cucumbers, cab-

bage, beans, and strawberry. Under exceptional circumstances vineyards are attacked and the foliage of fruit trees devoured, and instances are on record of invasions of greenhouses and of attack to stacks of fodder. The cannibalistic habit of the larvæ is well known, in which respect this insect resembles the boll worm.

The life history, as previously intimated, has not yet been carefully studied, the stage in which hibernation takes place being still in doubt. It was ascertained that hibernation does not take place in the egg condition, at least in the latitude of the District of Columbia, and it seems propable from all available data that this insect resembles the cotton worm (*Aletia xylina* Say), at least in its habit of hibernation. From specimens received during the past season from Georgia, adults were obtained during a warm spell in November, and it is the consensus of opinion of those who have given the subject of the biology of this insect any study that it probably passes the winter either as adult or as pupa, and from present knowledge evidently in the adult condition chiefly, although it is possible that larvæ may winter over.

The number of generations produced each year has been stated to be at least two in the northern limits of the species, and three for the south; but, from experience with related insects, the writer is inclined to accord this insect at least three generations for a climate like that of the District of Columbia, and four or more for the Gulf States. It is hoped that another year may see these points, as well as others, in the insect's life history made clear; as, for example, the time of the earliest appearance of the moth in different localities, the time of first egg-laying, and the period of all of the different stages, and the stage and place of hibernation.

The larvæ live like other cutworms in years of ordinary abundance, and are so dark and evidently secretive in their nature as to usually escape recognition. When, however, in seasons like the past, an undue increase in the numbers of the insect takes place and the habit of moving in armies is assumed, their presence becomes manifest, too late, however, in most instances, for remedial treatment.

Transformation to pupa takes place in little earthen cells, which may be either erect or somewhat inclined, but occasionally pupæ are not so protected.

A feature of the fall army worm's attack, and the one from which it has received its name, is that it is seldom observed to travel in numbers, save perhaps in the extreme South, until the fall, at least not earlier than the first of August, while the outbreaks of the common army worm occur usually prior to that time and seldom later.

NATURAL ENEMIES.

The fall army worm, on account of its somewhat smaller size, less conspicuous appearance and more concealed manner of living, and from

the fact that it is not usually found in such large armies, does not attract the same number of parasitic and predaceous enemies that have been recorded for the common army worm. During the past season the only natural enemies of the fall army worm observed were the English sparrow and some other birds, especially flickers, and a Tachinid fly, *Winthemia quadripunctulata* Wied., which deposits its eggs usually on or near the thoracic segments of its victim. A few other natural enemies have been observed in other years, which include ants, wasps, Ichneumon flies, and Chalcidids.

It is well known that two outbreaks of the true army worm have never yet come under observation in successive years, and it is to the efficiency of natural enemies that such a condition is ascribed. From the experience of the past year there is no reason to expect immunity from attack the coming year, as scarcely any dependence can be placed upon parasitic and predaceous insects and other animals with this species, and we know moreover that outbreaks may occur in successive years, as happened in Florida in 1896 and 1897, and in two other cases which have been recorded.

REMEDIAL MEASURES.

The fall army worm resembles so nearly the common army worm in seasons when it assumes the habit of traveling in armies that it is at such times amenable to much the same line of remedial treatment. The remedies of the greatest value against the latter are described in the Annual Report of this Department for 1879 (pp. 189, 190), and in Circular No. 4, second series, of this Division (pp. 3, 4).

Unfortunately, as with the common army worm, infestation is not reported, in fact is seldom detected, until too late for the application of direct remedies. When attack is at its height the larvæ or "worms" are usually approaching maturity, and it is difficult to check them at this stage or prevent them from passing from one field or garden to another. Paris green and other arsenicals are of value where they would not involve further injury to the crop infested or destroy it as food for man or beast.

Lawns can be freed from the caterpillars, at least in great measure, by the use of kerosene emulsion followed with as complete a drenching as possible with water from a hose.

If the earlier generations of the caterpillars could be discovered they could be destroyed in the same manner as other cutworms by the use of poisoned baits, this remedy being particularly applicable in vegetable gardens. Such baits should be made of succulent grasses or alfalfa, where the latter can be obtained, and saturated by immersion in a solution of Paris green or other arsenical.

By copiously spraying a wide strip of grass land surrounding unin

fested areas with Paris green, the insect could be prevented from spreading to them.

Rotation of crops should always be practiced, as well as the burning over of fields in the fall when the crops have become too badly injured for recovery. It is even advisable to burn over crops and to plow up fields just as soon as permanent loss is assured, and thus prevent infestation of neighboring crops.

Above all other precautions it is necessary to keep fields free from volunteer grain and wild grasses that would attract the moths for the deposition of their eggs, and thus serve as a breeding ground for the insects. A potent source of injury is the planting of one cereal after another with grasses, and the planting of crops in ground which has been permitted to run waste to wild grasses and weeds.

Before planting to grass and cereals the soil, particularly in the fall, should be thoroughly broken up by plowing and harrowing. Fall plowing is always to be practiced where suitable to the crop, the soil, and other conditions, and it is also well to follow with a harrow and level the ground where possible. For alfalfa, Professor Hunter recommends "disking," and for lawns a thorough going over with a long-toothed steel rake. Such methods of treatment serve to break up the cells in which the chrysalides are resting, as well as to destroy the larva when present in its several stages.

From the observations of Dr. Howard on the occurrence of this insect in 1881, it would seem obvious that where rice fields can be flooded many of these insects will be destroyed, and in localities where flooding is practicable there need be little fear of injuries. In many cases it is possible to overflow the fields at will, and, where necessary, negro laborers can be sent through fields to brush the "worms" from the stalks and leaf blades into the water.

During the outbreak of 1884 in Kansas it was learned that the ravages of this insect could be prevented by postponing the planting of wheat and rye until between September 20 and October 20.

THE STRAWBERRY CROWN MOTH.

(*Sesia rutilans* Hy. Edw.)

A destructive enemy to small fruits in the Pacific States and one particularly injurious to strawberry, blackberry, and raspberry in California is a borer larva of the Sesiid moth, *Sesia rutilans* Hy. Edw. Although the species has not often come to the notice of this office through correspondence, it has received some little attention at the hands of western entomologists and has already a considerable literature. Of recent reports of injury we have only one, that communicated by Mr. A. F. Bowen, Mountain View, Cal., February 26, 1900, when specimens were sent of crowns of strawberry that showed injury

by the larva, which was also present and included in this sending. Our correspondent wrote that while examining the plants last autumn he found that in disturbing the vines a clear-winged moth (the parent of this borer) often flew out.

As this insect does not appear to have received notice, even casually, in any of our official governmental publications, the present paper has been prepared.

INJURY AT SANTA CLARA, CAL.

Among the insects collected several years ago by Mr. A. Koebele while acting as special field agent of this Division in California this species was prominent.

April 22, 1887, Mr. Koebele found numerous specimens of this species, at that time in larva and chrysalis form, in the roots of strawberry at Santa Clara, Cal. In the field examined about one-half of all the plants were infested. Injury became manifest only after the old main root was destroyed. All the chrysalides observed were in cocoons formed of bits of roots within the roots and near an opening. The mature moths began issuing April 30, and continued until July 2, being most numerous toward the end of May.

May 26 of the following year Mr. Koebele made a careful examination of the same field in which the insects had been observed previously and noticed a general improvement. In places where plants had been killed, many new ones had come up and larvæ and pupæ were exceedingly rare. This was believed to be due to the free use of water during the preceding spring, which resulted in the destruction of the larvæ, many dead and moldy specimens of which were found, as well as some which were parasitized. From material gathered at this time adults were again reared, the last individuals issuing July 24. Among this lot was an unusual variation, which Mr. Koebele described as being entirely black. July 14 of the same year this species was reared from raspberry. The larva was found boring in the roots up into the dead stump, pupating about one inch above ground.

BIOLOGIC LITERATURE.

The first record that I find of the habits of this species is that published by Mr. J. J. Rivers, in Volume III of Papilio (p. 26), in January, 1883. This is a short note from correspondence, and is headed *Ægeria hemizoniæ* Hy. Edw. It is quoted in full:

> I have reared this species from the larva, a pallid grub with a darker head, feeding in the roots, rhizome, or base of the canes of the cultivated raspberry, and devouring the pith therein. This is looked upon by fruit growers as a direful insect, killing the plant, root and branch, but the injury is not so great as supposed. The larva feeds only on the pith, the loss of which is not immediately fatal, even to the part affected, much less to the whole. I have observed these Ægerian larvæ always in

otherwise unhealthy plants, such as are infested with "scale," and mostly with the tumors of the "woolly aphis" upon their roots. This last condition is usually accompanied by bad cultivation.

In the Pacific Rural Press of June 25, 1887 (vol. 33, p. 559), a letter by Dr. Riley addressed to Mr. I. A. Wilcox, Santa Clara, Cal., is published. The species is here mentioned as *Ægeria impropria* Hy. Edw., by which name it also received mention in most subsequent publications bearing upon the biology of this insect.

At a meeting of the Entomological Society of Washington, held June 2, 1887 (see Proceedings, Vol. I, p. 85, published March 1, 1888), specimens of the several stages of this species were exhibited by Dr. Riley with the statement that it was injurious in the larval stage to strawberries in southern California. He stated that he had for several years known that great injury to the roots of strawberry was occasioned by some lepidopterous borer, but the species had remained undetermined until about that time.

In 1888 Mr. W. G. Klee, State inspector of fruit pests, gave a popular account of this species in the Third Biennial Report of the State Board of Horticulture of California for that year (pp. 243, 244). This includes an illustration of the three stages of the insect and a statement that the common practice of flooding the vines has a great tendency to kill out the insect when in the larval stage, the opinion being expressed that if the water were retained for four or five days during the winter over the plants all larvæ would probably be killed.

In August of the same year Mr. Rivers published a second note on this insect with an account of its occurrence in the roots of cultivated blackberry. It was found equally at home in this plant, and caused the foliage and fruit to be dwarfed, dried, and valueless. (Entom. Amer., Vol. IV, p. 99.)

Recently Messrs. C. V. Piper and R. W. Doane gave a popular economic account of this species in Bulletin 35 of the Washington State Agricultural Experiment Station, dated May, 1898 (pp. 13–17), and during 1899 a short general account by Dr. Otto Lugger was published in that writer's Fourth Annual Report as Entomologist of Minnesota, page 64.

DESCRIPTION OF THE SPECIES.

According to recent studies of Mr. Beutenmüller on the Sesiidæ of North America, the insect in question must be referred to the species described by Henry Edwards in November, 1881, in Papilio (Vol. I, pp. 186, 187), under the name of *Albuna rutilans*. The type was a single female captured at Virginia City, Nev.

The adult, like other species of the Sesiidæ or clear-winged moths, is noticeable on account of the transparency of the wings, particularly of the hinder pair, the slender body, and the tuft of the apex of the abdomen, which, in life, is spread out like a fan. The moths are

diurnal in habit, flying swiftly in the heat of the day, when they might easily be mistaken for wasps, an effect due to their slender form, transparent hind-wings, and bright metallic colors.

The female moth is shown in the figure at *a*. It has a wing expanse of about seven-eighths of an inch (18 to 22 mm.). The ground color of the body and head is black with yellow stripes and bands. The antennæ are bluish black, and the legs are yellow ringed with black. The fore-wings are broadly bordered with brown and black, with a purple iridescence. Between the veins are thin stripes of yellow. The outer border of both wings is fringed with brown, that portion of the hind-wings nearest the base being fringed with yellow. The abdomen is tufted at the tip with yellow and black.

The male (*b*) is similar, but smaller and more slender, the anal tuft being longer and wider and blue-black in color.

A full description with bibliography and notes is given by Beutenmüller (Bul. Am. Mus. Nat. Hist., Vol. VIII, pp. 130, 131, 1896).

The remarkable variability of this species is illustrated by the number of names that have been given to it by its original describer. According to Beutenmüller, the synonyms are *Ægeria aureola*, *hemizoniæ*, *lupini*, *perplexa*, *impropria*, *washingtonia* and *madariæ* ♂, all described in volume I of Papilio.

The present known habitat includes Marin and Mendocino counties, and Sierra Nevada, Santa Clara, and Sausalito, Cal.; Virginia City and elsewhere in Nevada, Washington, Colorado, and Texas. The species is obviously native, and as the last-mentioned locality is based on a single male collected many years ago, either there is some reasonable doubt as to the authenticity of the capture or the species has a rather unusual range for an indigenous insect.

EARLIER STAGES DESCRIBED.

In the accompanying illustration the immature stages were drawn at the time of the receipt of the specimens; the adults were finished more recently.

The larva.—The larva, shown in the illustration at *c* at work within a strawberry stem, is of the usual cylindrical form and white color of the Ægerians and of nearly uniform diameter from the first thoracic to the last two abdominal segments, where the body tapers strongly. The second thoracic segment is just perceptibly widest, a little wider than the middle abdominal, and the last joint is quite narrow. The head is reddish brown and partially concealed beneath the first thoracic segment. The mandibles are black and the legs brownish with small dark-brown or black claws. The body has a few small brownish hairs scattered over each segment. In a general way this larva very closely resembles congeneric species, such as *pyri* and *acerni*, being of about the same size as the former. The length is about $\frac{6}{10}$ of an

inch (15^{mm}) when contracted, and $\frac{8}{10}$ of an inch (20^{mm}) when fully extended, the width being a little less than an eighth of an inch (3^{mm}).

The pupa, or chrysalis (see *d*), is formed in a cocoon which the larva spins about itself early in June—in Washington State, constructed principally of brownish castings woven together by means of fine silken strands. The chrysalis itself is reddish brown in color, about one-half inch long and with several rows of blackish spines crossing the back, the last row being larger and extending further around on the sides. The wings, antennæ, and long sucking tube may be seen folded underneath the body.

The cocoon is constructed within the burrow of the larva, and usually made near the center of the crown of the plant; but just before the emergence of the moth, the pupa, like others of its kind, and with the assistance of the sharp spines on its back, wriggles its way partially out of the cocoon, and after the escape of the moth the empty pupa skin is left projecting from the former home of the larva, as shown in the illustration at *e*.

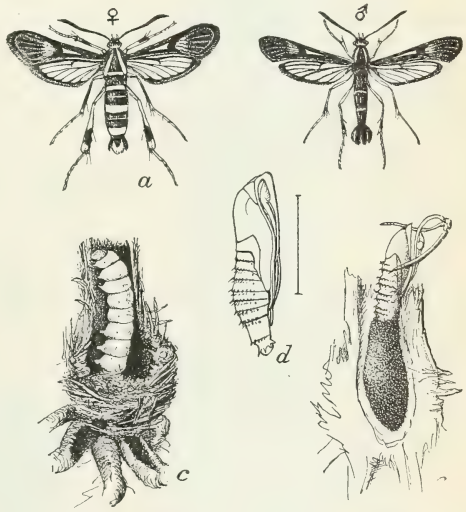

FIG. 20.—*Sesia rutilans*: *a*, female moth; *b*, male; *c*, larva at work in strawberry stem; *d*, pupa; *e*, pupal cell in stem, showing empty pupal case after escape of moth—*a*, *b*, *c*, *e*, about one-third enlarged; *d*, twice natural size (original.)

METHODS OF CONTROL.

Submersion.—From the observations of Messrs. Koebele and Klee, it is evident that the submerging of affected fields, where this can be accomplished, is sufficient, when properly done, for the suppression of the pest. This means of control is particularly applicable in localities where irrigation is practiced, the best time for submersion being, theoretically at least, as soon as possible after the fruit has been gathered.

It would be interesting to learn how common this practice is, and just how practicable it may be in the regions most affected by the insect.

Insecticides valueless.—Where submersion cannot be practiced, it would appear that remedial measures will be very difficult of application. In fact, we are confronted by much the same difficulties that present themselves in our efforts to control the nearly related squash-vine borer. The concealed mode of life of the larva renders the use of insecticides practically out of the question, the only one that would

give any good results being bisulphide of carbon, and it is doubtful if this could be applied profitably. The pupa is equally difficult to reach.

Protection with netting.—Choice plants, it is true, could be protected by means of close-mesh netting, which should be applied just before the appearance of the moths in July and retained in place until after the period of ovulation.

Cutting out infested and weak plants.—For the most efficient means of control in the absence of the practicability of submersion, we must have recourse to the heroic treatment which has already been recommended by Piper and Doane, and which consists in watching the plants closely for evidences of injury in the early spring, and then digging out and destroying by burning all infested or weakened plants that might serve as a breeding place for the species. After the plants have served their usefulness, they should be plowed under. It would be well to look carefully over all wild or volunteer growth of all of the known food plants of this species, and to pursue the same methods with these, destroying all useless plants.

THE BLACK GOOSEBERRY BORER.

(*Xylocrius agassizii* Lec.)

December 27, 1898, Dr. James Fletcher, entomologist and botanist of the Dominion of Canada, wrote that a Longicorn beetle, *Xylocrius*

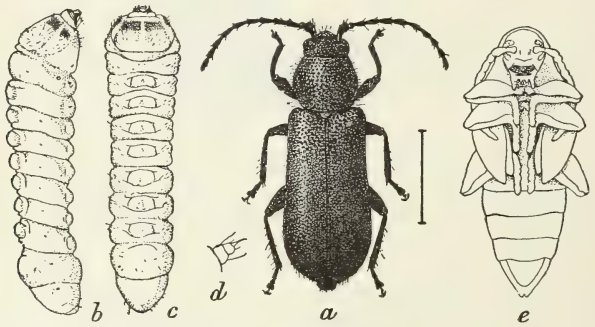

FIG. 21.—*Xylocrius agassizii: a*, beetle; *b*, larva, lateral view; *c*, same, dorsal view; *d*, larval antenna; *e*, pupa —*a*, *b*, *c*, *e*, three times natural size; *d*, more enlarged (author's illustration.)

agassizii Lec., had recently been reared from a larva imported from Oregon into British Columbia, and found boring the stems of gooseberry. Injury by the species was detected by some of the stems breaking when being handled. All of the consignees of this particular stock were visited, and Dr. Fletcher believes that the bushes were inspected before the beetles could have emerged.

From specimens furnished by Mr. E. A. Carew-Gibson, Victoria, British Columbia, the accompanying figure 21 was made by this Divi-

FIG. 22.—Gooseberry stem infested by *Xylocrius agassizii*—reduced one-third (from photograph by E. A. Carew-Gibson).

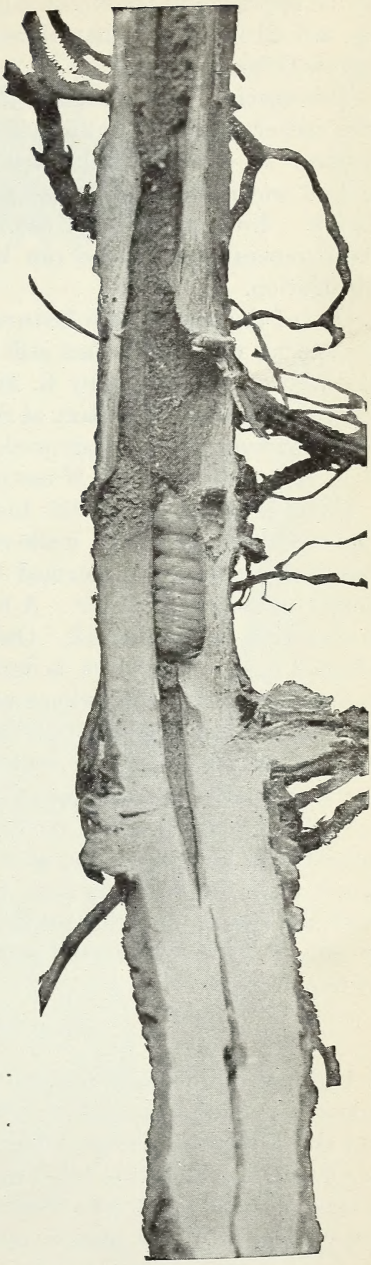

FIG. 23.—Gooseberry stem showing larva of *Xylocrius agassizii*—slightly enlarged (photograph by Carew-Gibson).

sion and loaned to Dr. Fletcher for use in an article upon this species which appeared in his entomological report for the year 1898 (1899, pp. 207–210). The other illustrations are from photographs by Mr. Carew-Gibson.

This species, represented in the adult form at *a* of figure 21, resembles rather closely Callidium, as also Asemum, being related to both genera. It is deep, dull black in color, rather sparsely pubescent, and of inconspicuous appearance, measuring about half an inch in length. No description of the larvæ or pupæ has yet been made, but their general appearance can be made out from the accompanying illustration.

One of the remarkable features about this attack is that previously the species was, and in fact still is, a rarity in collections. Injury was also noticed at Victoria by R. M. Palmer, and the infested bushes were traced to a nursery company at Salem, Oregon. Several hundred trees were condemned and destroyed, and it is hoped that the species has been effectually checked, if not exterminated, in the infested region.

Little is known of the life history of this gooseberry borer. Mr. Carew-Gibson, however, made some observations. A larva which he had under notice transformed to pupa August 19, and appeared as imago eighteen days later. A beetle was also found ready to emerge from a twig September 13. Only a single larva is to be found in each affected bush. The larva is described as generally starting in from a convenient crotch somewhere about where the branch makes a fork (and where the eggs are perhaps laid by preference); then working downward and apparently wintering in the roots. In one case noticed the larva had worked so near to the earth that there must have been only the thinnest possible covering between it and the soil; it then appeared to bore upwards, after the manner of the raspberry cane-borer, and after reaching some inches above ground made a chamber with a very thin covering dividing it from the air; in this the insect pupated. From two reared beetles an egg was obtained on the 15th of September.

METHODS OF CONTROL.

Until we know more concerning the life history and habits of this gooseberry borer, no other remedy can be advised than the cutting out and destruction by burning of the injured plants as soon as they are detected. If future observations should show that the same insect attacks also currants, which seems probable, it will be necessary for the protection of one plant to adopt the same measures with the other.

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